MD-304

HUMAN HEALTH RISK ASSESSMENT
MARTIN STATE AIRPORT
Middle River, Maryland

LOCKHEED MARTIN

Tetra Tech
Environmental Engineers & Scientists
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Human Health Risk Assessment
Martin State Airport
Middle River, Maryland

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EXECUTIVE SUMMARY

A human health risk assessment (HRA) was conducted to evaluate the chemical concentrations detected in the soil, sediments, and groundwater at the southeast portion of Martin State Airport, Middle River, Maryland. The HRA also evaluated potential exposures associated with the recreational use of the Frog Mortar Creek based on the detected chemical concentrations in the sediment and surface water at the Creek. Groundwater beneath the Site is not, and will not be, a source of potable or industrial water. Furthermore, a deed restriction will also be imposed to prevent use of the groundwater at the Site. The current and future land use of the Site, coupled with the deed restriction, support the premise that there is no complete pathway to the groundwater. Although the detected concentrations in groundwater were compared to screening criteria, groundwater was not evaluated as a medium of concern in the HRA.

The results of the risk characterization demonstrate that potential exposures to the soil and sediments at the Site resulted in theoretical risk and hazard index estimates that are either within an acceptable range or that are below the *di minimis* level of risk. Although the concentrations of antimony in subsurface soil translated to a hazard index that was the primary contributor to the cumulative hazard index of 5, these results do not necessarily suggest that adverse health effects will occur. Furthermore, the Interim Final Guidance of the State of Maryland, Department of the Environment, "Cleanup Standards for Soil and Groundwater", August 2001, states that remedial action is required when "contaminant concentrations in the soil media exceeds a traditional hazard index of 100." Based on this guideline, the concentrations of antimony in subsurface soil do not warrant further action. The evaluation of potential exposures to the surface water and sediments in Frog Mortar Creek while engaged in recreational activities also demonstrated that there are no unacceptable levels of risk and health hazard. Since the conservative evaluation of recreational users at Frog Mortar Creek indicated that there are no unacceptable exposures, it is unlikely that the much shorter exposures of a trespasser, if any, would pose a health problem.

The evaluation of lead in the surface soil predicted a blood level of 2.6 ug/dl among the 95th percentile of exposed occupational workers compared to the acceptable level of 10 ug/dl. The concentrations in the subsurface soil predicted a blood level of 8.5 ug/dl compared to an acceptable level of 10 ug/dl.

The estimated risks and hazard indices are presented in the following table:

Exposure Scenario	Estimated Carcinogenic Risks	Estimated Hazard Index
On-Site Worker		
Soil	3 E-05	0.02
Sediment	3 E-06	--
Future Construction Worker		
Soil	4.E-06	5
Sediment	1E-06	--
Recreational User		
Sediment	1E-06	0.007
Surface Water	8.E-08	0.002

Although exposures to the surface water and sediments in Frog Mortar Creek resulted in risk estimates that are below the *di minimis risk* of 1 E-06, the results of the fate and transport modeling (*Final Data Gap Investigation and Modeling Report*, Tetra Tech, 2004) predicted that the chemical plumes on-Site could ultimately reach the Creek. Risk-based cleanup goals will be developed for specific constituents in groundwater that could be transported to the Creek. These constituents included trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride, and dissolved cadmium. Risk-based levels (RBLs) were developed for these constituents under the assumption that these constituents will ultimately reach the surface water in Frog Mortar Creek. The calculated RBLs in surface water would be health-protective of the recreational users at Frog Mortar Creek, and were based on a target risk of 1 E-06 and a target hazard index of 0.1 for each chemical of concern.

The calculated RBLs for surface water in the creek are presented in the table below.

Analyte	**Risk-based Levels in Surface Water**
TCE	0.01 mg/L
cis-1,2-DCE	1.1 mg/L
Vinyl chloride	0.004 mg/L
Cadmium	0.2 mg/L

The corresponding target cleanup goals for groundwater are the chemical concentrations that will not exceed the surface water RBLs when, and if, the chemical plumes in groundwater will ultimately reach Frog Mortar Creek. To calculate the target groundwater cleanup goals that would be protective of the recreational user, a dilution factor will be incorporated to account for the dilution in the groundwater concentrations by the time it recharges into the Creek. The target cleanup goals for groundwater will be identified in the Remedial Action Plan for the Site.

Section 1
INTRODUCTION

On behalf of Lockheed Martin Corporation, Tetra Tech has prepared this human health risk assessment (HRA) that was conducted for the southeast portion of Martin State Airport located in Middle River, Maryland ("Site"). A *Draft Technical Memorandum – Human Health Risk Assessment, Martin State Airport*, was submitted to the Maryland Department of the Environment (MDE) to obtain a consensus on the proposed methodology and assumptions of the HRA. Comments from MDE were received on June 18, 2004 and incorporated into the *Final Technical Memorandum – Human Health Risk Assessment, Martin State Airport*, dated July 2004. However, based on recent information about the current land use and the future land use restrictions that will be imposed on the property, the exposure conditions for the current and future on-site commercial/industrial workers, as described in the Technical Memorandum, were modified to reflect the site-specific conditions. A more detailed discussion on the modifications is presented in Section 4.

1.1 Guidance Documents

The risk assessment was conducted in accordance with the following guidance documents:

Risk Assessment Guidance for Superfund (RAGS), Part A, Vol. 1: Human Health Evaluation Manual, USEPA, 1989;

Exposure Factors Handbook, Volume 1, General Factors, 8/97. EPA/600/P-95/002Fa.

Risk Assessment Guidance for Superfund, Part A, Vol. 1: Human Health Evaluation Manual, Supplemental Guidance Manual, "Standard Default Exposure Factors", USEPA, 1996;

Dermal Exposure Assessment: Principles and Applications, USEPA, 2002;

Updated Dermal Exposure Assessment Guidance, Region 3 Technical Guidance Manual, 2003,

Guidance for Data Usability in Risk Assessment, USEPA, 1992;

Superfund Exposure Assessment Manual (USEPA, 1988). and

Risk Assessment: Technical Guidance Manual, USEPA Region 3, EPA/903/R-93-001, January 2003.

State of Maryland Department of the Environment, Cleanup Standards for Soil and Groundwater, Interim Final Guidance (Update No. 1), August 2001.

1.2 Purpose and Objectives

The purpose of this HRA is to evaluate the likelihood that exposures to the chemical concentrations in the soil, sediments, and surface water would manifest in adverse health effects to the exposed individuals.

One objective of this HRA is to obtain concurrence from the MDE that the Site could be proposed for closure if (a) there are no unacceptable levels of risk associated with the chemical concentrations in the soil and sediments, at the Site, and (b) there are no potential health effects associated with exposures of recreational users to sediments and surface water at Frog Mortar Creek. If the results of the HRA should demonstrate that the estimated levels of risk are unacceptable, another objective of this HRA is to develop risk-based cleanup goals based on the current and anticipated use of the Site.

1.3 Scope of the Baseline Health Risk Assessment

The HRA was based on data from (a) soil and sediment investigations conducted from 2000 through 2002, (b) sediment and surface water sampling conducted in July 2004, and (b) groundwater sampling conducted within the past two years. The groundwater data were collected from approximately 42 wells at the Site, thus, providing the most current understanding of Site conditions.

One element of the HRA is to identify those chemical constituents (i.e., chemicals of potential concern) that pose potential health risks to human receptors based on their prevalence, concentrations in environmental media (i.e., soil), inherent toxicity, and human use of the identified areas of concern. Another element is to calculate the chemical intake (i.e., dose) to the receptors who could be exposed. This is accomplished by identifying the complete and significant pathways by which humans could potentially contact the COPCs in the areas of concern. Dose assessment predicts the amount of chemical intake (i.e., dose) of a potential receptor at a particular exposure point or location. Dose-receptor functions are used to correlate exposure doses to health effects. This information can then be used to calculate and characterize the risk to exposed receptors. Each component of the risk assessment process involves uncertainties; some are difficult to quantify because of uncertainties in the data, and others result from a lack of complete understanding of the underlying toxicological processes (e.g., multi-stage carcinogenesis). A qualitative uncertainty analysis is presented along with the risk characterization in order to aid the risk management decision-making process.

1.4 Organization of the HRA

Section 2 presents the background information on the Site. The physical and environmental setting, as well as a summary of the previous investigations, are discussed in this section. Section 3 describes the identification of chemicals of potential concern (COPCs). This section describes the evaluation of collected data and the screening process that was conducted in order to focus the HRA on the chemicals that failed the screening evaluation. Section 4 is the exposure assessment and presents the conceptual site model (CSM) that provided the framework of the exposure assessment. Section 4 also describes the different factors that were considered in evaluating how, and to what extent, potential exposures could occur. These factors include land use, the human receptors that could be potentially exposed, and how the human receptors could be exposed. Applicable chemical-specific properties were incorporated in estimating the chemical dose to each exposed individual. Section 5.0 presents the sources of the toxicity values that were used to estimate the potential risk associated with exposures to each identified COPC. Section 6 discusses the risk characterization and Section 7 discusses some of the uncertainties inherent in a risk assessment. Section 8 presents the conclusions and Section 9 presents the development of cleanup goals. The references used in the preparation of this HRA are listed in Section 10.

Section 2
SITE BACKGROUND

2.1 Site Location and Description

The Site is located at 701 Wilson Point Road in Middle River, Maryland on the southeast portion of Martin State Airport. The Site is bounded by Frog Mortar Creek to the east, and the main airport runway to the west (Figure 1 in Appendix A).

2.2 Site Geology

The uppermost 10 to 20 feet of soil consists of fill materials that were placed during construction of the airport in the 1950s (Army Corps of Engineers Soil Profile Map, 1956). The fill materials are composed of heterogeneous layers of sands, silts and clays, with debris that includes concrete, scrap metal, brick, glass, and wood.

Beneath the surficial layer of fill materials, the uppermost native soils are heterogeneous sands, silts, and clays. In general, coarser-grained materials (well graded sands to poorly graded fine sands) were dominant from approximately 15 to 45 feet below mean sea level (msl). Finer-grained materials, primarily of low to medium plastic clay, occur from approximately 65 to 75 feet below msl (Tetra Tech, 2004).

2.3 Site Hydrogeology

Groundwater elevations in the wells have ranged from 1.10 to 7.55 feet above msl from 2002 through 2004. The groundwater flow direction is to the east toward Frog Mortar Creek (Tetra Tech, 2003). Due to the Site's proximity to Frog Mortar Creek, a 12-hour tidal influence study was conducted on June 7, 2002, as described in the "Chemical Delineation and Groundwater Modeling Report", dated December 27, 2002. During the study, groundwater elevations fluctuated up to 0.31 feet due to tidal influence.

2.4 Previous Investigations

This section summarizes the Site investigations conducted by the Maryland Aviation Administration (MAA) and by Lockheed Martin Corporation.

2.4.1 MAA's Investigations

The MAA identified the investigation area in July 1991 when four drums were encountered adjacent to Taxiway Tango during trenching activities for the installation of an electrical cable. Based on the discovery of these buried drums, MDE required the MAA to investigate the surrounding area for potential impacts to soil and groundwater (Correspondence from MDE, 1/6/92 and 1/14/97).

The MAA conducted several investigations at the southeast portion of Martin State Airport from 1992 through 1996. The results of the investigations indicated that there are four areas of concern (AOCs), namely:

- *Taxiway Tango Median Anomaly Area* – several anomalous zones potentially containing buried metal.
- *Drum Area* – previous site investigations conducted in 1996 uncovered several drums during surface vegetation clearing.
- *Two Existing Ponds* – historical records suggest that acids may have been discharged during the 1950s and 1960s at the locations where two ponds currently exist.
- *Petroleum Hydrocarbon Area* – a petroleum hydrocarbon area was encountered at the Site in 1996. The petroleum hydrocarbon area is located approximately 200 feet west of the ponds.

2.4.2 Lockheed Martin Corporation's Investigations

Sampling Groundwater Monitoring Wells - 1999

In March 1999, Lockheed Martin collected groundwater monitoring well data to obtain updated chemical data on groundwater quality, groundwater elevation, and flow direction at the Site. Samples were collected from six monitoring wells, and the results showed that five volatile organic compounds (VOCs) [*cis-1,2-dichloroethene, toluene, 1,1 1-trichloroethane (TCA), trichloroethene (TCE), and vinyl chloride*] and two dissolved metals (*beryllium* and *cadmium)* were present above the Maximum Contaminant Levels (MCLs) for drinking water.

Source Identification and Assessment Program - 2000

Additional investigations (*Source Identification and Assessment Program, Tetra Tech, 2000*) were conducted from March through June 2000 to identify the potential source/sources of the chemicals in groundwater. Each of the four AOCs listed in Section 2.4.1 was investigated through a combination of excavations, localized trenching, soil borings, and sampling and analyses of soil, sediments, and groundwater samples (Tetra Tech, 9/2000). VOCs, petroleum hydrocarbons, and metals were detected in the soil and groundwater during this investigation. VOCs and metals were detected in the soil, and VOCs were detected in the groundwater above MCLs.

Chemical Delineation Investigations – 2001 -2002

Based on the results of the source identification and assessment, further investigations were conducted from December 2001 through December 2002. The objective was to delineate the lateral extent of chemical occurrence in the near-surface groundwater at the Site. A limited number of deep wells were installed to evaluate the vertical extent of VOCs and metals in the groundwater. The results of the lateral investigations indicated that the potential source areas are the Taxiway Tango median area, the drum area, and the petroleum hydrocarbon area and Pond #1 – see Section 2.4.1. During this round of investigation, the primary contaminants were identified to be TCE, vinyl chloride, and cis-1, 2-DCE. The groundwater modeling suggested that VOCs in groundwater appear to be migrating from west to east toward Frog Mortar Creek (Tetra Tech, 2002).

Data Gap and Hydrogeologic Investigation - 2003

Additional multi-level monitoring wells were subsequently installed to characterize the lateral and vertical extent of groundwater contamination. Data gaps in the shallow groundwater investigation, and further evaluation of the vertical extent of groundwater contamination were addressed in the data gap investigations conducted in 2003. The objectives of the data gap investigations were, (1) to delineate the eastern and western extent of chemicals in groundwater, (2) to characterize the chemicals within the existing plumes, (3) to characterize the geology of the surficial aquifer, and (4) to conduct quarterly monitoring to track and evaluate chemical trends in the groundwater. To attain these objectives, a total of 32 wells consisting of shallow, intermediate, and deep monitoring wells were installed at the site. The lateral and vertical distribution of chemical concentrations in groundwater indicate that three potential source areas (drum area, petroleum hydrocarbon and Pond #1 area, and Taxiway Tango median area) are present at the site contributing to three primary groundwater plumes. Based on the concentration and frequency of detection, three chlorinated VOCs (cis-1,2-DCE, TCE, and vinyl chloride) and one metal (dissolved cadmium) are considered the primary chemicals of concern.

Groundwater Modeling – 2003 -2004

Fate and transport modeling was conducted to evaluate dynamic changes of the chemical plumes, in particular with respect to plume migration toward Frog Mortar Creek. The distribution of VOCs in groundwater suggests that dechlorination of TCE to its daughter products cis-1,2-DCE and vinyl chloride is occurring. Therefore, the RT3D (Reactive Transport in 3-Dimensions) model code was used to model sequential decay reactions associated with VOC fate and transport. Numerical modeling of chemical fate and transport has predicted chemical concentrations of the plumes in the next 15 years.

2.4.3 Sediment and Surface Water Investigations

In May 2000, sediment samples were collected from Ponds #1 and #2 and analyzed for metals, VOCs, SVOCs, PCBs, and pesticides. In July 2004, Tetra Tech collected sediment and surface water samples from Frog Mortar Creek and surface water samples from the ponds. Rather than rely on the results of a fate and transport modeling, the sediment and surface water data collected from Frog Mortar Creek would indicate the current actual chemical levels, if any, that could be used to evaluate the potential exposures of recreational users at the Creek.

Section 3
IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

3.1 Data Evaluation

As discussed in Section 1, the HRA was based on data from (a) soil and sediment investigations conducted from 2000 through 2002, (b) groundwater sampling conducted within the past two years, and (c) sediment and surface water sampling conducted in July 2004. Figure 2 in Appendix A shows the locations of the samples that were collected during these investigations.

The data from the previous investigations were reviewed to ensure that the quantity and quality of the analytical data were suitable for risk assessment purposes. The quality of the data was evaluated based on the quality control samples that were collected and analyzed. Field quality control samples included field duplicates and trip blanks. Laboratory control samples included surrogate spikes. The quantity of quality control samples collected and analyzed were sufficient to be representative of the field samples collected. All collected samples were analyzed for the specified analytes, and the holding times for each analytical method were met.

The collected data characterized the lateral and vertical distribution of chemicals in each area of concern (AOC). In the *Final Technical Memorandum – Human Health Risk Assessment, Martin State Airport* (Tetra Tech, 2004), it was stated that the HRA will assume two exposure areas, namely (1) based on an on-site worker's activities within each AOC, and (2) based on an on-site worker's activities Site-wide. However, more current information indicates that a worker's activities on-site are not limited within the boundaries of each AOC, thus, an AOC-specific risk evaluation does not have a defensible rationale. Consequently, the HRA was premised on Site-wide exposures of an on-site worker. Site-wide is defined as the southeast portion of the airport as depicted in Figure 1 in Appendix A.

Information on the historical operations at the Site indicated that the potential sources of release consist of buried drums and debris (MES, 1994). Based on this information, the site investigations focused on collecting soil samples from a depth of one foot bgs to a maximum depth of 15 feet bgs. The data from the one-foot samples were used to evaluate surface soil exposures, and the data from one-foot bgs to a maximum depth of 15 feet bgs were used to evaluate subsurface soil exposures.

3.2 Identification of Chemicals of Potential Concern (COPCs)

This section describes the methodology of the screening evaluation that was intended to generate a reduced set of chemicals that will be evaluated quantitatively in the risk assessment. The methodology was consistent with the recommended methodology in the *Risk Assessment: Technical Guidance Manual* (USEPA Region 3, 2003).

3.2.1 Soil COPCs

Tables 1 and 2 in Appendix B show the list of analytes detected in surface and subsurface soil, respectively. Each Table also shows the number of samples collected, the number of samples with detectable concentrations, the practical quantitation limit (PQL), the frequency of detection, the range of detected concentrations, the maximum reported concentrations, and the industrial risk-based concentrations (RBC) published by EPA Region 3. The initial step was to compare the practical quantitation limit (PPQL) of each chemical to the corresponding industrial RBC. The purpose of this comparison was to assure that a chemical reported as non-detect was not excluded from the HRA if the PQL is higher than the industrial RBC. If a chemical was not detected in all soil samples, and its PQL was at or lower than the EPA Region III industrial RBC, then the chemical was excluded from the quantitative risk assessment. However, if the PQL is higher than the industrial RBC, a chemical that was reported as a non-detect in all soil samples was still included in the risk assessment.

The next step in the screening evaluation was to compare the maximum concentration to the USEPA Region III industrial RBC. The identification of COPCs was based on the following:

- A chemical with a maximum detected concentration in soil that was higher than the industrial RBC was identified as a COPC.

- A chemical that was reported as a non-detect in all of the soil samples but had a reporting limit that was higher than the industrial RBC, was also identified as a COPC.
- A chemical with a maximum concentration that was lower than the industrial RBC was not identified as a COPC, thus, was eliminated from the quantitative health risk assessment.
- A chemical that was not detected in all of the soil samples and with a reporting limit that was lower than the industrial soil RBC was also eliminated from further evaluation in the risk assessment.
- A detected chemical without a published industrial RBC was identified as a COPC.

The soil COPCs are listed in the Table below.

Surface Soil COPCs	Subsurface Soil COPCs
Arsenic	Antimony
Lead	Arsenic
Mercury	Cadmium
Benzo(a)anthracene	Copper
Benzo(a)pyrene	Lead
Benzo(b)fluoranthene	Mercury
Dibenz(a,h)anthracene	Nickel
Indeno(1,2,3-cd)pyrene	Vinyl chloride
Carbazole	Carbazole
	PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

PAHs – polycyclic aromatic hydrocarbons

It should be noted that lead, mercury, and carbazole were identified as COPCs because there are no published RBCs.

3.2.2 Groundwater COPCs

Table 3 in Appendix B presents the screening evaluation of the groundwater. The methodology was similar to the screening evaluation of the soil data except that the point of comparison was the tap water RBC established by USEPA Region III. Based on these screening criteria, the groundwater COPCs include arsenic, cadmium, benzene, carbon tetrachloride, 1,1-dichloroethane (DCA), 1,2-DCA, 1,1-dichloroethene (DCE), cis-1,2-DCE, trans-1,2-DCE, toluene, ethylbenzene, methylene chloride, trichloroethene (TCE), tetrachloroethene (PCE), 1,2,3-trichlorobenzene, 1,1,2-trichloroethane (TCA), 1,2,4-trimethylbenzene (TMB), 1,3,5-TMB, vinyl chloride, xylenes, and naphthalene.

3.2.3 Sediment COPCs

The sediment samples from the ponds and Frog Mortar Creek were analyzed for inorganic constituents, VOC, semi-VOCs, and PAHs. Table 4 in Appendix B lists the constituents detected in the sediment samples. To identify sediment COPCs for the HRA, the highest sediment concentrations were compared to the industrial soil RBCs used to identify the soil COPCs because the recreational users at Frog Mortar Creek would come into contact with the sediments in the same manner that they would be exposed to soil. The results of the screening evaluation demonstrated that arsenic is the only inorganic sediment COPC in Frog Mortar Creek, whereas benzo (a) pyrene was the only sediment COPC in the pond sediments.

3.2.4 Surface Water COPCs

The surface water samples from the ponds and Frog Mortar Creek were analyzed for inorganic constituents, VOC, semi-VOCs, and PAHs. Table 4 in Appendix B also lists the detected constituents in the surface water samples. The highest surface water concentrations were conservatively compared to the tap water RBCs, and the results indicated that TCE and MTBE were the surface water COPCs from Frog Mortar Creek.

Section 4
EXPOSURE ASSESSMENT

The exposure assessment identifies and describes potentially exposed human receptors, develops exposure pathways, and estimates the chemical concentration at the point where a human receptor could come into contact with the soil, surface water, sediments, and groundwater at the Site (i.e., exposure point concentration).

4.1 Conceptual Site Model

Figure 3 in Appendix A presents the conceptual site model (CSM) that was used as the framework for evaluating the potential exposures. Based on the current and future land use, the exposure assessment identifies the populations who could be potentially exposed, the means by which exposure could occur, and the amount of chemical intake into the body from each exposure medium. The CSM also indicates whether specific exposure pathways are complete or incomplete, and incomplete pathways are excluded from the HRA. It should be noted that although the exposure pathways to groundwater are actually incomplete, potential exposures via dermal contact and inhalation of emissions were included in the evaluation in order to be consistent with the Technical Memorandum.

4.1.1 Potential Exposure Pathways

An exposure pathway is the mechanism by which a human receptor is exposed to chemicals from a source. The four elements of a complete exposure pathway are:

- a source of chemical release,
- a mechanism of release through a transport medium, i.e., release of chemicals in the soil through indoor air or through dust particles,
- a point of contact between the potential receptor and the transport medium, i.e., ingestion of soil, and
- a potential receptor, i.e., an on-site worker.

If any one of the four elements is missing, the exposure pathway is considered incomplete. Only complete exposure pathways would result in exposures.

Current potential exposure pathways are those that exist as a result of the current extent of contamination, combined with existing land use and human activity patterns. Future exposure pathways include pathways that have a reasonable probability of completion based on projected future land use and predicted human activity at the Site. The most likely means of future pathway completion is chemical migration from one medium to another or changes in land use.

The proposed future land use of the Site will be similar to the current land use, as stipulated in a deed restriction that will be recorded for the Site. In addition to the fact that the area is within the taxiway of the airport, there are no future plans of having buildings or structures at the Site. This will be documented in the terms of a deed restriction that will be imposed on the Site that will prohibit residential, commercial, and industrial development. Therefore, potential exposures do not include potential exposures through inhalation of indoor air emissions from volatile COPCs that could enter a building through the foundation.

Another Site-specific condition in this HRA is the absence of groundwater use at the Site. The groundwater beneath the Site is not, and will not be, a source of potable or industrial water supply. This Site-specific condition eliminates one of the components of a complete exposure pathway, i.e., a point of contact between a potential human receptor and the transport medium, namely, groundwater. Therefore, the exposure pathway to groundwater is incomplete, and was not evaluated in the HRA.

Construction and/or excavation activities at the Site would be limited to shallow depths and are not likely to expose construction workers to the groundwater. Furthermore, the construction workers would be in protective clothing that prevents or eliminates possible contact with perched groundwater that could be present intermittently. Therefore, the exposure pathways to groundwater under the construction scenario were also considered incomplete.

To summarize, the current and future exposure pathways for on-Site workers include the following:

- Incidental ingestion of surface soil and sediments,
- Dermal contact with surface soil and sediments,
- Inhalation of air-borne particulates

To allow for the possibility that operations at the Site might require occasional or intermittent construction/excavation activities to a maximum depth of five feet bgs, the current and future construction worker was assumed to come into contact with the surface and *subsurface* soil. Since the shallowest groundwater table is deeper than five feet bgs, the current and future construction worker is not anticipated to have potential exposures to groundwater. Therefore, the current and future construction worker is assumed to have potential exposures through:

- Incidental ingestion of surface and subsurface soil, and sediments,
- Inhalation of air-borne particulates, and
- Dermal contact with surface and subsurface soil, and sediments.

Human receptors have restricted access to the existing ponds where benzo (a) pyrene was detected in one out of six sediment samples. Despite the restricted access, however, the HRA proceeded to evaluate potential exposures of the on-site worker to benzo (a) pyrene detected in the sediment sample from Pond #1. Arsenic was the only sediment COPC detected in Frog Mortar Creek.

Potential exposures of the current and future recreational user to arsenic, the only sediment COPC in Frog Mortar Creek, were evaluated in the HRA. However, since there were no surface water COPCs in the pond areas, exposure pathways to surface water in the ponds were considered incomplete and were not evaluated in the HRA. In contrast, TCE and methyl tertiarybutyl ether (MTBE) were identified as surface water COPCs in the Creek. Therefore, the HRA evaluated potential exposures of recreational users to surface water in the Creek through incidental ingestion and dermal contact.

4.1.2 Current and Future Receptors

The current and future land use are anticipated to be similar, thus, the current and future receptors are the on-Site workers, the construction worker involved with excavation or redevelopment activities, and the recreational user.

4.2 Quantification of Exposure

This section describes the quantification of the chemical intake or exposure doses. These exposure doses provided the basis for subsequent risk calculations based on dose-response relationships. The reasonable maximum exposure (RME) approach was used to provide an estimate of the maximum exposure that might occur (EPA, 1989). Under the RME scenario, the intent is to conservatively quantify an exposure that is still within the range of possible exposures.

4.2.1 Estimation of Concentration at the Point of Exposure

The 95 percent upper confidence limit (95% UCL) of the mean concentration of each COPC was used to estimate the concentration at the point of exposure (i.e., exposure point concentration or EPC). The 95% UCL provides reasonable confidence that the true site average will not be underestimated (EPA, 1992c).

The ProUCL software from the USEPA National Exposure Research Laboratory, Environmental Sciences, was used to calculate the 95% UCL. Since the calculation of the 95% UCL depends on the distribution of the data set, i.e., normal, lognormal, parametric, the ProUCL software performs the necessary statistical tests and recommends the appropriate UCL. If the data set was determined to be non-parametric, the 95% Chebyshev UCL was typically applied. If the data was normally distributed, then the Student's t UCL was used as the exposure point concentration (EPC). If the 95% UCL was higher than the maximum concentration, then the maximum detected concentration was used as the EPC.

Air exposure pathways to the non-volatile COPCs could occur through inhalation of chemicals bound to dust-borne particulates. Potential transport of chemicals in the soil through dust particulates was based on a particulate emission factor (PEF).

The highest chemical concentrations that were detected in sediments and surface water were used to evaluate the potential exposures of a recreational user.

4.2.2 Exposure Parameters

The exposure parameters for this HRA are presented in the following Table. Default exposure frequency of an industrial worker (EPA, 1989; EPA ,1997) are not applicable at this Site because the on-site worker would not be present within the boundaries of the Site 5 days a week for 50 weeks a year. Instead, the HRA assumed that the on-site worker would be present at the Site for only 2 days a week for 50 weeks a year.

The exposure duration of one year for a construction worker was based on a more conservative estimate of the extent of most redevelopment activities. Activities associated with excavation or non-redevelopment activities will be significantly shorter and this is discussed within the context of the uncertainties in the HRA.

Since the likely recreational activities at Frog Mortar Creek would be fishing, boating, or wading, it was assumed that the recreational user could be along the shoreline and would come into contact with the sediments. Recreational usage was based on spending time at the Creek for a total of two days a week for eight months or 35 weeks a year. This is based on the assumption that weather conditions would not make it feasible to engage in outdoor activities at the Creek for four months a year.

Summary of Exposure Parameters
Martin State Airport

Exposure Assumptions	On-Site Worker	Construction Worker	Recreational User
Body Weight (kg)	70	70	70
Averaging Time Non-Carcinogens (yrs)	Same as exposure duration	Same as exposure duration	Same as exposure duration
Averaging Time Carcinogens (days)	25,550	25,550	25,550
Ingestion Rate (mg/day)	50	480	70
Exposure Frequency (days/yr)	100[a]	250	70 [b]
Exposure Duration (years)	25	1	25
Inhalation Rate (m^3/day)	20	20	20
Skin Surface Area (cm^2)	5,670	5,670	5,670
Adherence Factor (mg/ cm^2) – soil Permeability constant – water	Chemical-specific	Chemical-specific	Chemical-specific

a – based on 2 days a week, 50 weeks a year   b – based on 2 days a week, 35 weeks a year

4.2.3 Ingestion Algorithm

The equation for calculating the soil intake through ingestion is as follows:

$$IngestionDose = \frac{(Cs\ or\ Csw)\ x\ IR\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AT}$$

where:

Ingestion Dose	=	ingestion dose (mg/kg-day)
Cs	=	EPC in soil or sediment (mg/kg) or
Csw	=	EPC in surface water
IR	=	ingestion rate (mg/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)
CF	=	unit conversion factor

4.2.4 Inhalation Algorithm

The equation for calculating intake through inhalation of dust from Site soil is as follows:

$$Inhalation\ Dose = \frac{EPCa\ x\ InhR\ x\ ET\ x\ EF\ x\ ED}{BW\ x\ AT}$$

where:

Inhalation Dose	=	inhalation dose (mg/kg-day)
InhR	=	inhalation rate (m^3/day or m^3/hr)
EPCa	=	EPC in air particulates (mg/m^3)
	=	(concentration in soil or sediment) x (1/PEF)

where:

PEF = particulate emission factor (m^3/kg),

ED = exposure duration (years)

EF = exposure frequency (days/year)

BW = body weight (kg)

AT = averaging time (days)

4.2.5 Dermal Algorithm

The equation for calculating intake through dermal contact with soil is as follows:

$$Dermal\ Dose = \frac{(Cs\ or\ Csw)\ x\ SSA\ x\ ABS\ x\ AF\ x\ EF\ x\ ED\ x\ CF}{\mathrm{BW\ x\ AT}}$$

where:

Dermal Dose	=	dermal dose (mg/kg-day)
C_s	=	EPC in soil or sediment (mg/kg) or
Csw	=	EPC in surface water
AF	=	soil to skin adherence factor (mg/cm^2),
Or PC	=	permeability constant (cm/hr) for water
SSA	=	exposed skin surface area (cm^2/day)
ABS	=	absorption fraction of chemical from soil or sediment
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	unit conversion
BW	=	body weight (kg)
AT	=	averaging time (days)

Section 5
TOXICITY ASSESSMENT

Toxicity assessment is based on the ability of a compound, at an administered dose, to elicit an adverse human health response. For risk assessment purposes, toxic chemical effects were separated into two categories of toxicity: carcinogenic effects and non-carcinogenic effects. This division relates to the currently-held scientific opinion that the mechanisms of action for these endpoints differ. For carcinogens, it was assumed that any level of exposure has a finite possibility of causing cancer; therefore, there is no threshold dose for carcinogenic effects. That is, a single exposure to a carcinogenic chemical may, at any level, result in an increased probability of developing cancer. For a chemical exhibiting non-carcinogenic effects, it is believed that humans have protective mechanisms that must be overcome before the adverse effect results; therefore, there is a threshold dose for these effects. This threshold concept view of non-carcinogenic effects holds that a range of exposures up to some defined threshold can be tolerated by humans without appreciable risk of harm.

5.1 Carcinogenic Toxicity

For carcinogens, it is assumed that any level of exposure has a finite possibility of causing cancer; therefore, there is no threshold dose for carcinogenic effects. That is, a single exposure to a carcinogenic chemical may, at any level, result in an increased probability of developing cancer. The USEPA evaluates chemicals that have carcinogenic effects in a two-step process. In the first part of the evaluation, both human and experimental animal studies are reviewed to determine the weight of evidence that a chemical is carcinogenic. Then a weight-of-evidence classification is assigned to the compound.

In the second part of the evaluation, a slope factor (SF) is calculated, which is an estimate of the slope of the tumor dose-response curve at relatively high doses. This curve is used to calculate cancer risk from any given exposure dose. To ensure an adequate margin of safety, the SF is taken from the slope of the 95^{th} percentile upper-bound confidence level of the tumor dose-response curve from extensive animal carcinogenicity data. Thus, the actual slope factors estimating carcinogenic potency could be lower, but are not likely to be higher.

5.2 Noncarcinogenic Toxicity

The threshold dose for noncarcinogenic effects can be related to a reference dose (RfD). A chronic RfD is an estimate of a daily exposure level to which people, including sensitive individuals, do not have an appreciable risk of suffering significant adverse health effects.

For a chemical exhibiting non-carcinogenic effects, it is believed that humans have protective mechanisms that must be overcome before the adverse effect results; therefore, there is a threshold dose for these effects. This threshold concept view of non-carcinogenic effects holds that a range of exposures up to some defined threshold can be tolerated by humans without appreciable risk of harm.

The noncarcinogenic, or threshold, health effects of a chemical are evaluated using a reference dose (RfD) approach. A RfD is a conservative estimate of the daily intake of a chemical (milligram of chemical per kilogram body weight per day) that is without risk of any threshold health effects in humans, including sensitive subpopulations (women of child-bearing age and children).

The primary sources of toxicity values are IRIS (USEPA, online) and HEAST (USEPA 1997b). The slope factors and reference doses used in estimating the risks and hazard indices are shown in Tables 5 to 8 in Appendix B.

5.3 Evaluating Health Effects of Lead

Adverse health effects associated with exposure to lead have been correlated with concentrations of lead in whole blood and not with intake of lead by an individual. Exceedances over 10 micrograms per deciliter (μg/dl) of lead in whole blood are considered levels that could indicate adverse effects. The health effects of lead were evaluated by using the Leadspread model to predict the percentile of blood lead concentration for child and adult populations.

Section 6

RISK CHARACTERIZATION

This section of the BHHRA describes how calculated exposure doses were integrated with the toxicity criteria to yield estimated of potential health risks. Risk characterization involves the integration of health effects information, developed as part of the dose-response assessment, with exposure estimates developed as part of the exposure assessment. The result is a quantitative estimate of non-threshold carcinogenic risks, as well as a quantitative estimate of chronic and noncarcinogenic hazards based on the presumption that a threshold dose is required to elicit a response.

The U.S.EPA considers a risk range of 1 in 10,000 to 1 in 1,000,000 (1E-04 to 1E-06) as a target range within which to manage human-health risk (40 CFR, Section 300.430(e)(2)(i)(A); U.S.EPA, 1991). It is generally accepted that risks greater than this range require attention. The one-in-a-million level of risk is often referred to as the "de minimis" level of risk; human-health risks below this range would not require attention.
The document *Cleanup Standards for Soil and Groundwater* (State of Maryland, Department of Environment, August 2001) also states that a contaminant is considered a hotspot if the concentration exceeds a traditional risk calculation of 1E-04 or a hazard index of 100.

6.1 Carcinogenic Risk Estimates

The theoretical excess lifetime cancer risk is an estimate of the increased risk of an individual developing cancer as a result of exposure to the COPCs at specified daily dosages averaged over a lifetime of 70 years. The excess lifetime cancer risk will be estimated for each known, probable, or possible carcinogenic constituent, by using the following equation:

$$\textit{Excess Cancer Risk} = \textit{Exposure Dose} \times \textit{Slope Factor}$$

Lifetime daily intakes, using an averaging time of 70 years, effectively prorate the total cumulative dose over a lifetime. This approach is based on the assumption that a high dose of carcinogens received over a short period of time, at any age, is equivalent to a correspondingly low dose received over a lifetime.

6.2 Noncarcinogenic Effects

The hazard quotient (HQ) is the ratio of the estimated exposure dose to the RfD. This ratio is used to evaluate noncarcinogenic health effects due to exposure to a constituent. An HQ greater than 1 indicates that the estimated exposure dose for that constituent exceeds acceptable levels for protection against noncarcinogenic effects. Although an HQ of less than 1 suggests that noncarcinogenic health effects should not occur, an HQ of slightly greater than 1 is not necessarily an indication that adverse effects will occur. The sum of the HQs is termed the hazard index (HI).

Since some individuals are exposed by more than one pathway, HQs are summed for each pathway that contributes to the exposure to the same individual in a given population. If the total hazard index is equal to or less than 1.0, it is believed that no threshold health effects will occur. An HI of slightly greater than 1, however, is not necessarily an indication that health effects will occur. Summing HQs across all chemicals and across all pathways assumes that all acute and chronic human health effects are additive. Since this assumption is known not to be accurate, when a total population hazard index exceeds 1.0, it is appropriate to re-examine the health effects, and to segregate the individual hazard quotients on the basis of target organ or mechanism of action.

6.3 Results of the Risk Characterization

The estimated cancer risks for each potential receptor are described below and tabulated in Table 11. Detailed calculations are presented in Tables 5 through 10 in Appendix B.

6.3.1 Risks Associated with Exposures of an On-Site Worker

Based on the site-specific exposure conditions of the on-site commercial/industrial worker, the cumulative cancer risk estimate due to potential soil exposures is 3×10^{-5} (Table 5 in Appendix B). The primary contributors to the estimated risks are ingestion and skin contact with benzo(a)pyrene in soils within one foot of soil. The chemical-specific risk attributed to benzo(a)pyrene is 2×10^{-5}.

Under the same exposure assumptions, the cumulative hazard index is 0.02 and is well below the threshold level of 1. Hence, the estimated cancer risk due to potential soil exposures of an on-Site worker is within range considered acceptable by the USEPA. The estimated hazard index is below the threshold level of 1.

The HRA also evaluated the unlikely scenario that an on-site worker's exposure to the sediments in the ponds would occur at the same frequency and duration as the potential exposure to soil. Based on these assumptions, potential exposures of an on-site worker to the benzo (a) pyrene in the pond sediments would lead to an estimated risk of 3×10^{-6} (Table 6 in Appendix B). There are no available toxicity factors for noncarcinogenic effects of benzo(a)pyrene, hence, there is no estimated hazard index.

6.3.2 Risks Associated with Exposures of a Future Construction Worker

The construction worker is assumed to be a 70-kilogram male working at the site for 8 hours per day, 5 days per week for a total of one year. Combined ingestion of soil particles at a rate of 480 milligrams a day (EPA, 1997a), inhalation of dust, and adherence of soil particles to the skin provide the basis for exposure dose calculations. Under these conditions, the estimated cancer risk is 4×10^{-6} (Table 7 in Appendix B), and the hazard index is 5. The major contributor to the hazard index is antimony (HI=2).

If a construction worker is assumed to come into contact with the benzo (a) pyrene in the sediments at the pond, the total cancer risk estimate is 1×10^{-6} (Table 8 in Appendix B). There are no available toxicity factors for noncarcinogenic effects of benzo(a)pyrene, hence, there is no estimated hazard index.

6.3.3 Risks Associated with Exposures of a Recreational User to Sediment

Table 9 in Appendix B shows the estimated risk and hazard index estimates due to potential exposures of recreational users to the arsenic in the sediments at Frog Mortar Creek. The estimated cancer risk due to potential contact with the sediments is 1×10^{-6} and the estimated hazard index is 0.007. These results demonstrate that there are no harmful health effects associated with potential exposures to sediments in Frog Mortar Creek.

6.3.4 Risks Associated with Exposures of a Recreational User to Surface Water

Potential exposures of recreational users to surface water in Frog Mortar Creek resulted in a risk estimate of 8.4×10^{-8} and a hazard index estimate of 0.002 (Table 10 in Appendix B). These results demonstrate that recreational users of Frog Mortar Creek are not likely to have adverse health effects from wading in or coming into contact with the surface water at the Creek.1

6.3.5 Evaluation of Lead

Table 12 in Appendix B shows that potential exposures of an on-Site worker to the levels of lead in surface soil could result in 2.6 ug/dl of blood lead in 95^{th} percentile of the exposed population of workers. Table 13 in Appendix B shows that subsurface levels of lead could result in 8.5 ug/dl of lead to an occupational worker compared to the threshold level of 10 ug/dl.

6.4 Discussion of Results

The findings of the HRA suggest that the potential exposures of an on-Site worker to the surface soil at the site resulted in a cancer risk estimate that is within the acceptable risk range of 1E-06 to 1E-04. The primary contributor to the cumulative risk is the highest concentration of benzo(a)pyrene in a soil sample collected from one location in the Drum Area. The concentrations of noncarcinogenic compounds in the surface soil do not pose adverse health effects to exposed on-Site workers.

Levels of lead were also detected in the surface and subsurface soil at the site. However, the predicted blood lead levels associated with potential exposures to these levels in the soil are below the threshold level of 10ug/dl. For the construction worker who might be involved with excavation activities, antimony at a depth of four feet bgs is the primary contributor to a hazard index of 5. The highest concentration for antimony was in the sample location collected from the Taxiway Tango area. In contrast, the cancer risk estimate due to levels of detected carcinogens is in the acceptable range. Based on the assumption that a construction worker could come into contact with the sediments in the ponds, the risk estimate demonstrated that there are no potentially adverse health effects associated with the construction worker scenario.

The results of the health risk assessment also indicated that there are no potential health concerns associated with coming into contact with the sediments and surface water at Frog Mortar Creek.

Section 7
UNCERTAINTY

7.1 Uncertainties in the Risk Assessment

This section discusses the uncertainties involved in the process of quantifying risk for human receptors. Because risk estimates are based on a combination of measurements and assumptions, it is important to provide information on sources of uncertainty in risk characterization.

7.1.1 Uncertainties in the Exposure Assessment

A prevailing uncertainty in the exposure assessment lies in the estimation of chemical intake or dose. The concentration at the point of exposure is a significant factor in the uncertainty of the risk estimates. It is evident from the data that the distribution of the chemical concentrations throughout the Site does not follow a normal distribution. In most cases, the exposure point concentration is biased high due to high concentrations present in soil samples from one or two locations. Therefore, overestimates in the calculated risks and hazard indices are likely.

A similar uncertainty exists in the evaluation of the construction worker scenario. Although the evaluation assumed a construction period of one year, actual construction or excavation activities may be considerably shorter. As a result, the risk and health hazard estimates associated with these assumptions could be overestimated.

Another uncertainty in the risk assessment is the use of generic exposure factors, in some cases, in lieu of chemical-specific factors. The ability to have chemical-specific factors for all chemicals under all exposure conditions is an ongoing process that relies on scientific data that requires rigorous evaluation. In the absence of such data, the HRA applied recommended default assumptions and factors that would err on the conservative side.

7.1.2 Uncertainties in the Risk Estimates

The estimated carcinogenic and noncarcinogenic risks are based on the assumption that effects are additive. It is recognized in the scientific community that chemical mixtures could have antagonistic or synergistic effects. Until more scientific evidence is made available, risk assessments err on the conservative side by assuming additive effects. This would lead to an overestimation of risk. On the other hand, if there are synergistic rather than additive effects, then the cumulative risks could be underestimated.

Section 8
CONCLUSIONS

The results of the risk characterization demonstrate that potential exposures to the soil and sediments at the Site resulted in theoretical risk and hazard index estimates that are either within an acceptable range or that are below the *di minimis* level of risk. The evaluation of potential exposures to the surface water and sediments in Frog Mortar Creek while engaged in recreational activities also demonstrated that there are no unacceptable levels of risk and health hazard. Since the conservative evaluation of recreational users at Frog Mortar Creek indicated that there are no unacceptable exposures, it is unlikely that the much shorter exposures of a trespasser, if any, would pose a health problem.

In conclusion, this health risk assessment demonstrates that the current use and the future land use stipulated for the site do not pose unacceptable cancer risks and health hazards to individuals who could be potentially exposed.

Section 9
DEVELOPMENT OF CLEANUP GOALS

Although exposures to the surface water and sediments in Frog Mortar Creek resulted in risk estimates that are below the *di minimis risk* of 1 E-06, the results of the fate and transport modeling (*Final Data Gap Investigation and Modeling Report*, Tetra Tech, 2004) predicted that the chemical plumes on-Site could ultimately reach the Creek. Risk-based cleanup goals will be developed for specific constituents in groundwater that could be transported to the Creek. These constituents included TCE, cis-1,2-DCE, vinyl chloride, and dissolved cadmium.

The development of risk-based levels (RBLs) in surface water that would be health-protective of the recreational users at Frog Mortar Creek is based on a target risk of 1 E-06 and a target hazard index of 0.1 for each chemical of concern. The calculated RBLs are presented in the table below, and the spreadsheet calculations are presented in Table 14 in Appendix B

Analyte	Risk-based Levels in Surface Water
TCE	0.01 mg/L
cis-1,2-DCE	1.1 mg/L
Vinyl chloride	0.004 mg/L
Cadmium	0.2 mg/L

To calculate the target groundwater cleanup goals that would be protective of the recreational user, a dilution factor will be incorporated to account for the dilution in the groundwater concentrations by the time it recharges into the Creek. The target groundwater cleanup goals will be calculated and presented in the Remedial Action Plan for the Site.

Section10
REFERENCES

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APPENDIX A
FIGURES

FIGURE 1
SITE LOCATION MAP

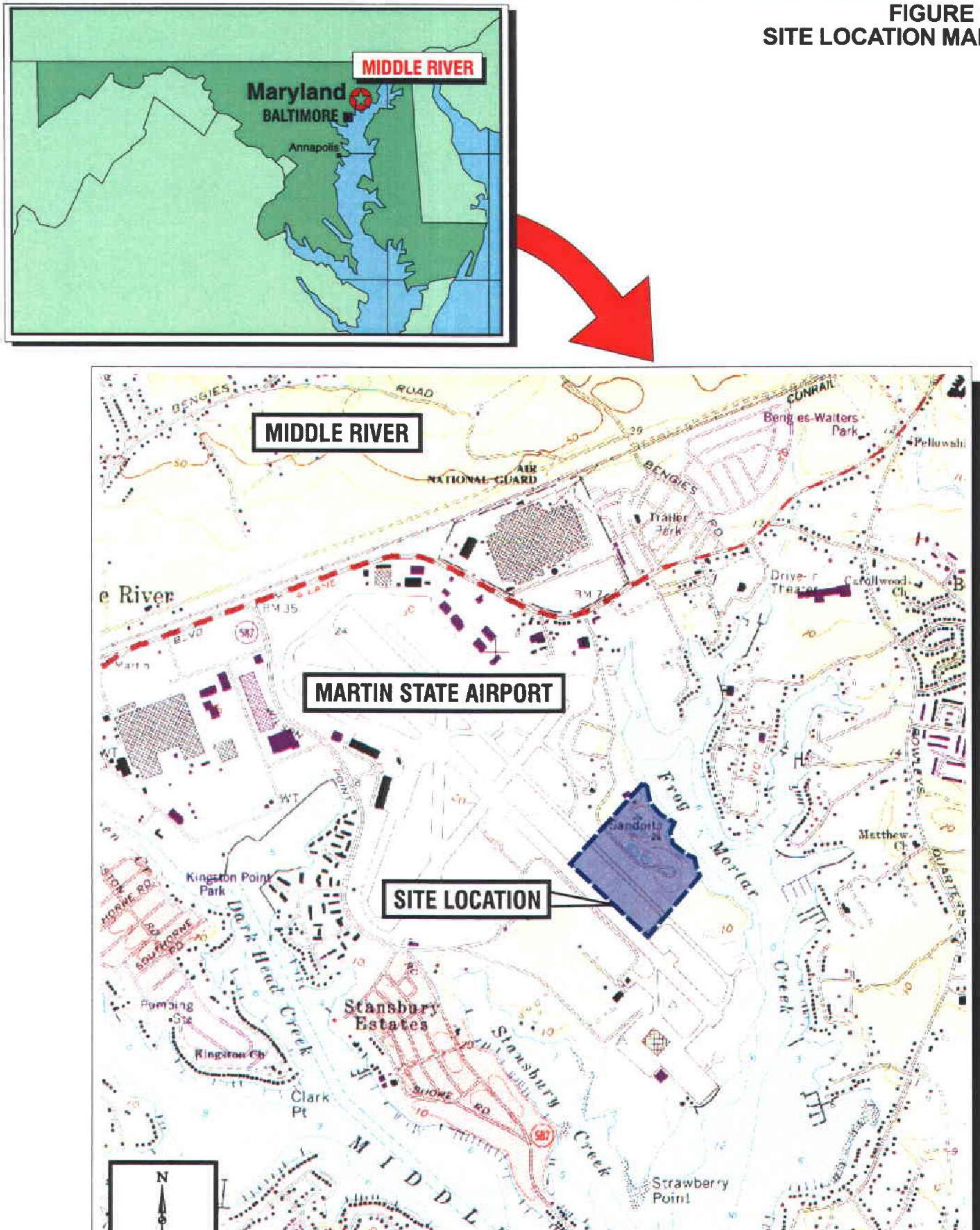

FIGURE 2
PREVIOUS SAMPLING LOCATIONS
MARTIN STATE AIRPORT

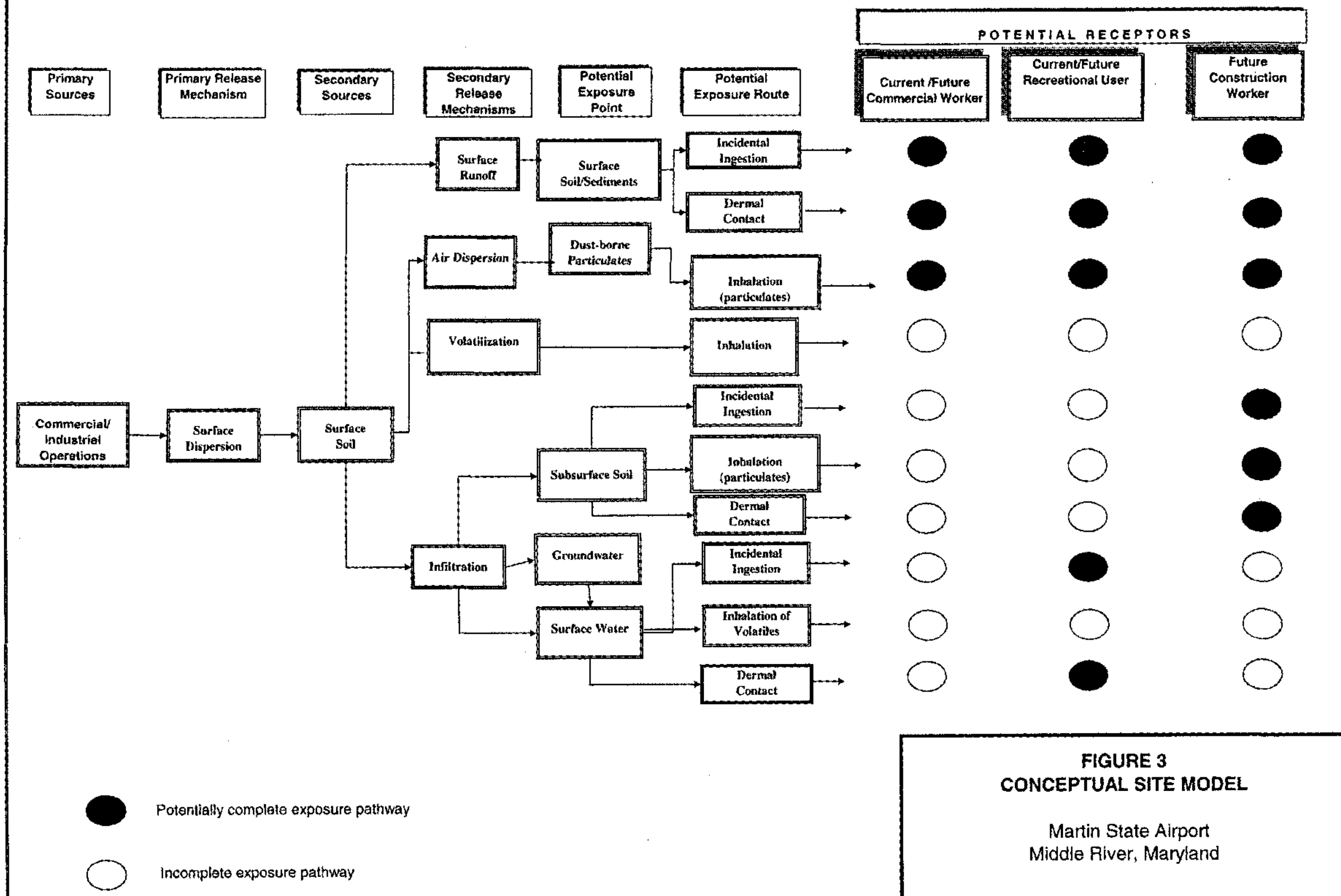

FIGURE 3
CONCEPTUAL SITE MODEL

Martin State Airport
Middle River, Maryland

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APPENDIX B
TABLES

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Region III RBC (mg/kg)	COPC vs Indl RBC	UCL
Inorganics									
Antimony	16	2.5	0	0%	--	--	410	No	
Arsenic	15	0.5	7	47%	0.25 - 29	29	1.9	**Yes**	21.3
Beryllium	15	2.5	1	7%	2.7	2.7	2000	No	
Cadmium	14	2.5	2	14%	0.71 - 13	13	510	No	
Chromium (Total)	14	2.5	14	100%	3.9 - 480	480	1500000	No	
Hexavalent Chromium	6	4	0	0%	--	38	3100	No	
Copper	15	2.5	14	93%	1.25 - 490	490	41000	No	
Lead	16	2.5	12	75%	7 - 320	320	NA	**Yes**	160
Mercury	14	0.04	10	71%	.07 - 0.72	0.72	NA	**Yes**	0.35
Nickel	16	2.5	15	94%	4.3 - 89	89	20000	No	
Selenium	16	2.5	2	13%	3.9 - 5.7	5.7	5100	No	
Silver	15	1	1	7%	2.1	2.1	5100	No	
Thallium	14	1.5	1	7%	25	25	72	No	
Zinc	15	2.5	14	93%	14 - 600	600	310000	No	
VOCs									
Acetone	14	0.025	2	14%	0.23 - 0.24	0.24	920000	No	
Acrolein	9	0.08	0	0%	--	--	--	No	
Acetophenone	6	0.33	0	0%	--	--	--	No	
Acrylonitrile	9	0.08	0	0%	--	--	--	No	
bis(2-Chloroethyl) ether	9	0.4	0	0%	--	--	--	No	
bis(2-Chloroisopropyl) ether	9	0.4	0	0%	--	--	--	No	
Bromobenzene	15	0.005	0	0%	--	--	--	No	
Bromomethane	16	0.005	0	0%	--	--	--	No	
n-Butylbenzene	15	0.005	0	0%	--	--	--	No	
sec-Butylbenzene	15	0.005	0	0%	--	--	--	No	
tert-Butylbenzene	15	0.005	0	0%	--	--	--	No	
bis(2-Chloroethyl) ether	9	0.4 - 0.54	0	0%	--	--	--	No	
Chlorobenzene	15	0.005	5	33%	0.079 - 0.23	0.23	20000	No	
Chloroform	14	0.005	0	0%	--	--	10000	No	
p-Isopropyltoluene	15	0.005	0	0%	--	3	NA	No	
Carbon Disulfide	15	0.005	5	33%	0.017 - 0.053	0.053	100000	No	
1,2-Dichloroethane	14	0.005	0	0%	--	0.048	31	No	
1,2-Dichlorobenzene	14	0.005	4	29%	.038 - .4	0.44	92000	No	
c-1,2-Dichloroethene	14	0.005- 0 0.5	42	300%	0.004 - 20	20	10000	No	
trans-1,2-Dichloroethene	15	0.005- 0 0.5	1	7%	0.016	0.016	20000	No	
Ethylbenzene	15	0.005	0	0%	--	--	100000	No	
Isopropylbenzene	15	0.005	0	0%	--	--	100000	No	
Methyl-t-butyl ether	105	0.005	0	0%	--	0.009	720	No	
Methylene Chloride	14	0.005	9	64%	0.006 - 0.051	0.051	380	No	

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Region III RBC (mg/kg)	COPC vs Indl RBC	UCL
4-Methyl-2-Pentanone	104	0.05 - 5	0	0%	--	0.214	NA	No	
n-Propylbenzene	15	0.005	0	0%	--	5.8	NA	No	
Styrene	15	0.005	0	0%	--	0.22	200000	No	
Tetrachloroethene	14	0.005	4	29%	.012 - 0.034	0.034	5.3	No	
Toluene	15	0.005	2	13%	0.013 - 0.016	0.016	200000	No	
Trichloroethene	15	0.005	5	33%	.032 - 6.5	6.5	7.2	No	
1,2,4-Trichlorobenzene	29	0.005	0	0%	--	0.21	10000	No	
1,1,2-Trichloroethane	15	0.005	0	0%	--	--	50	No	
1,2,4-Trimethylbenzene	16	0.005	0	0%	--	--	51000	No	
1,3,5-Trimethylbenzene	15	0.005	0	0%	--	--	51000	No	
1,1,2,2-Tetrachloroethane	15	0.005	0	0%	--	--	--	No	
1,1,1,2-Tetrachloroethane	105	0.005 - 0.5	0	0%	--	--	--	No	
1,1,1-Trichloroethane	15	0.005	0	0%	--	--	--	No	
1,2,3-Trichloropropane	15	0.005	0	0%	--	0.014	1.4	No	
Vinyl chloride	15	0.005	0	0%	--	--	4	No	
Xylenes	15	0.015	0	0%	--	--	200000	No	
SVOCs									
Butyl benzyl phthalate	9	0.4	0	0%	--	--		No	
bis(2-Ethylhexyl) phthalate	9	0.4	1	11%	0.2 - 13	13	200	No	
Carbazole	9	0.4	3	33%	0.83 - 8	8	NA	Yes	4.6
Di-n-butyl phthalate	8	0.4	0	0%	--	--		No	
Methoxychlor	57	0.006 - 0.001	0	0%	--	--		No	
2-methylnaphthalene	9	0.4	0	0%	--	--		No	
2,4,6-Trichlorophenol	65	0.33 - 4.95	0	0%	--	--		No	

Table 1. Identification of Surface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Region III RBC (mg/kg)	COPC vs Indl RBC	UCL
PAHs									
Acenaphthene	9	0.42	2	22%	0.2 - 0.92	0.92	61000	No	
Acenaphthylene	9	0.42	0	0%	--	--	61000	No	
Anthracene	9	0.4	3	33%	0.2 - 9.1	9.1	310000	No	
Benzo(a)anthracene	9	0.4	4	44%	0.99 - 31	31	3.9	Yes	17.6
Benzo (a) Pyrene	9	0.4	4	44%	1.0 - 25	25	0.39	Yes	14.7
Benzo (b) Fluoranthene	9	0.4	4	44%	0.87 - 22	22	3.9	Yes	13
Benzo (k) Fluoranthene	9	0.42	4	44%	0.87 - 20	20	39	No	
Benzo (g,h,i) Perylenea	9	0.4	4	44%	0.55 - 13	13	31000	No	
Chrysene	8	0.33	4	50%	1.1 - 31	31	390	No	
Dibenz(a,h) anthracene	10	0.4	3	30%	0.87 - 4.1	4.1	0.39	Yes	2.3
Fluoranthene	65	0.33 - 4.95	21	32%	0.53 - 64	64	41000	No	
Fluorene	65	0.33 - 0.66	7	11%	0.37 - 20	20	41000	No	
Naphthalene	24	0.005	0	0%	--	--	20000	Yes	
Phenanthreneb	9	0.4	5	56%	0.56 - 25	25	310,000	No	
Pyrene	9	0.4	5	56%	0.6 - 45	45	31000	No	
Indeno(1,2,3-c,d)pyrene	9	0.4	4	44%	0.2 - 13	13	3.9	Yes	7.8
2-Methylnaphthalene	65	0.33 - 4.95	4	6%	0.045 - 68	68	20000	No	
Pentachlorophenol	65	0.83 - 12.45	0	0%	--	--	24	No	
Pesticides/PCBs									
Aldrin	9	0.00006	0	0%	--	--		No	
PCBs	9	0.0005	0	0%	--	--		No	
alpha-BHC	9	0.00006	0	0%	--	--		No	
beta-BHC	9	0.00006	0	0%	--	--		No	
delta-BHC	9	0.00006	0	0%	--	--		No	
gamma-BHC (Lindane)	9	0.00006	0	0%	--	--		No	

NA - not available

Table 2. Identification of Subsurface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Region III RBC (mg/kg)	COPC vs Indl RBC	UCL
Inorganics									
Antimony	102	2.5	5	5%	1.0 -3600	3600	410	Yes	201
Arsenic	86	0.5	9	10%	0.25 - 27	27	1.9	Yes	13.1
Barium	518		23	4%	11.4 - 735	735	72000	No	
Beryllium	86	2.5	1	1%	14	14	2000	No	
Cadmium	87	2.5	17	20%	7 - 2,400	2,400	510	Yes	170
Chromium (Total)	102	2.5	96	94%	3.3 - 9,300	9,300	1500000	No	
Hexavalent Chromium	19	2	0	0%	--			No	
Copper	102	2.5	97	95%	1 - 130,000	130,000	41000	Yes	11849
Lead	102	2.5	43	42%	1 - 66,000	66,000	NA	Yes	4361
Mercury	100	0.04	54	54%	0.02 - 3	3	NA	Yes	0.39
Nickel	100	2.5	82	82%	4.2 - 42,000	42,000	20000	Yes	2308
Selenium	100	2.5	11	11%	2.8 - 701	701	5100	No	
Silver	86	1	14	16%	1 - 290	290	5100	No	
Thallium	100	1	8	8.00%	25 - 50	50	72	No	
Zinc	102	2.5	95	93.14%	9.1 - 36,000	36,000	310000	No	
VOCs									
Acetone	88	0.05	7	8%	.025 - 2.55	2.55	920000	No	
Acrolein	74	0.2	0	0%	--	0		No	
Acetophenone	12	0.33-4.95	0	0%	--	--		No	
Acrylonitrile	74	0.18	0	0%	--	--		No	
Bis (2-chloroethyl) ether	56	0.33	0	0%	--	--		No	
bis(2-Chloroisopropyl) ethe	56	0.33	0	0%	--	--		No	
Bromobenzene	86	0.005	0	0%	--	--	--	No	
Bromomethane	86	0.005	0	0%	--	--		No	
n-Butylbenzene	87	0.005	12	14%	0.0025 - 1.8	1.8	NA	No	
sec-Butylbenzene	87	0.005	19	22%	0.0025 - 2.2	2.2	NA	No	
tert-Butylbenzene	87	0.005	8	9%	.0025 - 0.65	0.65	NA	No	
n-propylbenzene	105	0.005	20	19%	0.002 - 5.8	5.8	100000[a]	No	
Carbon Disulfide	102	0.005	5	5%	0.002 - 0.25	0.25	100000	No	
Chlorobenzene	105	0.005	5	5%	0.09 - 0.25	0.25	20000	No	
Chloroform	103	0.005	1	1%	0.027	0.027	10000	No	
1,2-Dichloroethane	105	0.005	3	3%	.008 - .048	0.048	31	No	
1,2-dichlorobenzene	184	0.0025	12	7%	.008 - .44	0.44	92000	No	
cis-1,2-dichloroethene	105	0.005	39	37%	.025 - 20	20	10000	No	
t-1,2-DCE	105	0.005	22	21%	0.002 - 0.25	0.25	20000	No	
1,1,1-trichloroethane	103	0.005	0	0%	--		290000	No	
1,1,2-trichloroethane	103	0.005	1	1%	0.055	0.055	50	No	
1,1,2,2-tetrachloroethane	103	0.005	0	0%	--			No	
1,2,4-trichlorobenzene	186	0.005	2	1%	0.17 - 0.2	0.2	10000	No	
1,2,3-trichloropropane	103	0.005	1	1%	0.014	0.014	1.4	No	

Table 2. Identification of Subsurface Soil Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Region III RBC (mg/kg)	COPC vs Indl RBC	UCL
1,2,4-Trimethylbenzene	103	0.005	20	19%	.013 - 41	41	51000	No	
1,3,5-Trimethylbenzene	103	0.005	15	15%	0.14 - 32	32	51000	No	
Ethylbenzene	105	0.005	21	20%	0.4 - 20	20	100000	No	
Isopropylbenzene	103	0.005	21	20%	0.002 - 5.6	5.6	100000	No	
Methylene chloride	103	0.005	46	45%	0.001 - 0.913	0.913	21	No	
MTBE	103	0.005	1	1%	0.009	0.009	720	No	
Styrene	103	0.005	2	2%	0.2 - 0.22	0.22	200000	No	
Tetrachloroethene	103	0.005	12	12%	0.012 - 0.069	0.069	5.3	No	
Trichloroethene	103	0.005	39	38%	.01 - 7	7	7.2	No	
Toluene	87	0.005	24	28%	0.0025 - 2,000	2,000	200000	No	
p-Isopropyltoluene	103	0.005	21	20%	0.002 - 3	3	NA	No[b]	
Vinyl chloride	105	0.005	13	12%	0.006 - 5	5	4	**Yes**	0.423
Xylenes	105	0.005	26	25%	.026 - 300	300	200000	No	
SVOCs									
bis(2-Ethylhexyl) phthalate	56	0.33	9	16%	0.1 - 6.5	6.5	200	No	
Carbazole	56	0.33	5	9%	0.42 - 19	19	NA	**Yes**	2.1
PAHs									
Acenaphthene	56	0.33	6	11%	0.16 - 15	15	61000	No	
Acenaphthylene	56	0.33	0	0%	--	--		No	
Anthracene	56	0.33	4	7%	0.14 - 11	11	310000	No	
Benzo(a)anthracene	56	0.33	9	16%	0.16 - 18	18	3.9	**Yes**	2.1
Benzo (a) Pyrene	65	0.33	12	18%	0.16 - 25	25	0.39	**Yes**	2.8
Benzo (b) Fluoranthene	56	0.33	10	18%	0.65 - 7	7	3.9	**Yes**	1.1
Benzo (k) Fluoranthene	56	0.33	5	9%	0.15 - 7.4	7.4	39	No	2.2
Benzo (g,h,i) Perylenea	56	0.33	6	11%	0.6 - 5.8	5.8	31000	No	
Chrysene	65	0.33	15	23%	0.165 - 31	31	390	No	3.8
Dibenz(a,h) anthracene	65	0.33	3	5%	0.1 - 2.5	4.1	0.39	**Yes**	0.435
Indeno(1,2,3-c,d)pyrene	65	0.33	9	14%	0.165 - 13	13	3.9	**Yes**	
Naphthalene	65	0.33	28	43%	0.029 - 230	230	20000	No	
Phenanthrene	65	0.38	16	25%	0.165 - 120	120	310,000	No	
Pyrene	100	0.33	5	5%	0.0039 - 3.6	3.6	31000	No	
Pesticides/PCBs									
Aldrin	48	0.00006	0	0%	--	--		No	
PCBs	57	0.0005	2	4%	0.002 - 0.003	0.003	1.4	No	
alpha-BHC	48	0.00006	0	0%	--	--		No	
beta-BHC	48	0.00006	0	0%	--	--		No	
delta-BHC	48	0.00006	0	0%	--	--		No	
gamma-BHC (Lindane)	48	0.00006	0	0%	--	--		No	

NA - not available

a - based on structural homology

b - no available toxicity value

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (ug/L)	Number Of Detects	Frequency of Detection (%)	Range (ug/L)	Maximum Reported (ug/L)	Residential Region III Tap Water (ug/L)	COPC	UCL
Inorganics									
Antimony	236	0.13	1	0%	29	29	15	No	
Arsenic	235	5.0 - 50	33	14%	5.2 - 46	46	0.05	**Yes**	7.9
Beryllium	235	5	24	10%	5.1 - 9.7	9.7	73	No	
Cadmium	235	0.259 - 5	76	32%	10 - 2,600	2600	18.00	**Yes**	283
Chromium (Total)	235	0.1 - 5	121	51%	5.1 - 480	480	55555	No	
Copper	235	0.235	139	59%	5.4 - 690	690	1500	No	
Iron	11	1000	5	45%	1.0 - 2.0	2	11000	No	
Lead	235	0.138	90	38%	5.1 - 110	110	NA	No	
Mercury	235	0.04	5	2%	1 - 2.5	2.5	NA	No	
Nickel	235	5.0	173	74%	4.2 - 42,000	42,000	730	No	
Selenium	235	0.246	83	35%	5.1 - 110	110	180	No	
Silver	235	1.15	0	0%	--	--	180	No	
Thallium	234	5	0	0%	--	--	2.6	No	
Zinc	234	50	138	59%	56 - 2100	2,100	11000	No	
VOCs									
Acetone	120	4.15 - 50,000	3	3%	31-36	36	5500	No	
Acrolein	9	0.08 -0.26	0	0%	--	--	0.042	No	
Acetophenone	63	10	1	2%	21	21	610	No	
Acrylonitrile	9	0.08 - 0.26	0	0%	--	--	0.037	No	
Benzene	120	1	52	43%	1 - 860	860	0.34	**Yes**	296
bis(2-Chloroethyl) ether	9	0.4 - 0.54	0	0%	--	--	0.0096	No	
bis(2-Chloroisopropyl) ether	63	10.0 - 50	0	0%	--	--	0.26	No	
Bis (2-chloroethoxy) methane	63	10	0	0%				No	
Bromobenzene	120	0.446 - 5000	0	0%	--	--	--	No	
Bromochloromethane	120	0.4 - 5000	0	0%				No	
Bromodichloromethane	120	0.4 - 5,000	0	0%	--	--	0.17	No	
Bromoform	120	0.405	0	0%	--	--	8.5	No	
Bromomethane	120	0.368 - 5000	0	0%	--	--	8.5	No	
n-Butylbenzene	120	0.328 - 5,000	0	0%	--	--	--	No	
sec-Butylbenzene	120	0.4 - 5000	3	3%	2.0 - 25	25	--	No	
tert-Butylbenzene	120	0.473 - 5000	0	0%	--	NA	--	No	
bis(2-Chloroethyl) ether	63	10.0 - 50	0	0%	--	NA	0.0096	No	
Chlorobenzene	120	3 - 980	27	23%	0.079 - 0.23	0.23	110	No	
2-Chlorotoluene	120	0.37 - 5000	0	0%	--	--	120	No	
4-Chlorotoluene	120	0.498 - 5000	0	0%	--	--	--	No	
Chloroethane	120	0.332	0	0%	--	--	3.6	No	
Chloromethane	120	0.55	0	0%	0.024 - 0.064	0.064	190	No	
2-Chlorophenol	65	10.0 - 50	1	2%	6	6	30	No	
2-Chloronaphthalene	65	0.33 - 4.95	0	0%	--	--	--	No	

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (ug/L)	Number Of Detects	Frequency of Detection (%)	Range (ug/L)	Maximum Reported (ug/L)	Residential Region III Tap Water (ug/L)	COPC	UCL
Carbon tetrachloride	120	0.37	14	12%	2 - 330	330	0.16	**Yes**	170
p-Isopropyltoluene	105	0.005 0 0.5	18	17%	0.008 - 3	3	NA	No	
Dibromochloromethane	105	0.005 0 0.5	0	0%	--	--	0.13	No	
1,2-Dibromo-3-chloropropane	105	0.005 0 0.5	0	0%	--	--	0.047	No	
Carbon Disulfide	120	1.0 - 5,000	0	0%	0.017 - 0.053	0.053	1000	No	
Dibenzofuran	61	10	0	0%	0.279 - 14	14	12	No	
Dibromomethane	120	0.31	0	0%	--	--	0.00075	No	
1,1-Dichloroethane	120	0.278	11	9%	5 - 990	990	800	**Yes**	301
1,2-Dichloroethane	120	0.273	29	24%	2 - 310	310	0	**Yes**	267
1,2-Dichlorobenzene	202	0.397	2	1%	1 and 13	13	270	No	
1,3-Dichlorobenzene	202	0.397	0	0%	--	--	180	No	
1,4-Dichlorobenzene	202	0.366	0	0%	--	--	0.47	No	
1,1-Dichloroethene	120	0.459	37	31%	3 - 1700	1700	350	**Yes**	389
c-1,2-Dichloroethene	120	0.331	80	67%	4 - 120,000	120000	61	**Yes**	24945
trans-1,2-Dichloroethene	120	0.329	54	45%	0.329 - 1500	1500	120	**Yes**	391
2,4-Dinitrotoluene	61	10	0	0%	--	--	73	No	
2,6-Dinitrotoluene	61	10	0	0%	--	--	37	No	
1,2-Dibromoethane	120	0.384	0	0%	--	--	0.00075	No	
Ethylbenzene	120	0.244	27	23%	1.0 - 3700	3700	1300	**Yes**	683
Hexachlorobenzene	61	10	0	0%	--	--	0.042	No	
Hexachloroethane	63	10	0	0%	--	--	--	No	
2-Hexanone (MBK)	120	0.886	0	0%	--	--	--	No	
Isopropylbenzene	120	0.208	0	0%	0.066 - 5.6	5.6	660	No	
2-Butanone (MEK)	120	0.872	0	0%	--	--	7000	No	
Methyl-t-butyl ether	120	0.386	0	0%	0.009	0.009	2.6	No	
Methylene Chloride	120	0.375	44	37%	1 - 690	690	4	**Yes**	302
4-Methyl-2-Pentanone	120	0.409	3	3%	14 - 100	100	NA	No	
Nitrobenzene	63	10	0	0%	--	--	3.5	No	
n-Propylbenzene	120	0.364	15	13%	1.0 - 66	66	NA	No	
Styrene	120	0.547	0	0%	0.2 - 0.22	0.22	1600	No	
Tetrachloroethene	120	0.402	30	25%	1 - 120	120	0.1	**Yes**	245
Toluene	120	0.433	34	28%	2.0 - 9400	9400	750	**Yes**	1694
Trichloroethene	120	0.332	68	57%	2 - 52,000	52000	0.026	**Yes**	14643
1,2,3-Trichlorobenzene	120	0.735	33	28%	2 - 280	280	7	**Yes**	173
1,2,4-Trichlorobenzene	202	0.688	2	1%	1 - 470	470	7	No	
1,1,2-Trichloroethane	120	0.455	25	21%	2 - 190	190	0.19	**Yes**	166
1,2,4-Trimethylbenzene	120	100	27	23%	0.013 - 31	31	12	**Yes**	282
1,3,5-Trimethylbenzene	120	5	22	18%	2 - 260	260	12	**Yes**	253
1,1,2,2-Tetrachloroethane	120	0.5	1	1%	12	12	0.053	No	
1,1,1,2-Tetrachloroethane	120	0.473	0	0%	--	--	0.41	No	
1,1,1-Trichloroethane	120	0.376	2	2%	7 and 520	520	3200	No	
1,2,3-Trichloropropane	105	0.005 - 0.5	1	1%	0.014	0.014	0.0053	No	
Vinyl acetate	120	1.0 - 5.0	0	0%	--	--	410	No	
Vinyl chloride	120	1	67	56%	4 - 30,000	30,000	11.00	**Yes**	5709
o-Xylene	102	3	24	24%	2 - 5,000	5,000	210	**Yes**	862
p/m-Xylene	102	3	23	23%	3 - 33,000	33,000	210	**Yes**	

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (ug/L)	Number Of Detects	Frequency of Detection (%)	Range (ug/L)	Maximum Reported (ug/L)	Residential Region III Tap Water (ug/L)	COPC	UCL
SVOCs									
Butyl benzyl phthalate	9	04-0.54	0	0%	--	--	7300	No	
bis(2-Ethylhexyl) phthalate	61	10.0 - 50	0	0%	--	--	4.8	No	
Atrazine	6	0.33 - 4.9	0	0%	--	--	0.3	No	
Butyl benzyl phthalate	9	0.33 - 0.54	0	0%	--	--	7300	No	
Caprolactam	61	10	2	3%	29 - 180	180	18000	No	
Carbazole	61	10	1	2%	14	14	NA	No	4.6
3,3-Dichlorobenzidine	65	0.33 - 4.9	0	0%	--	--	0.15	No	
2,4-Dichlorophenol	65	0.33 - 4.9	0	0%	--	--	110	No	
1,2-Dichloropropane	105	0.005 - 0.5	0	0%	--	--	120	No	
1,3-Dichloropropane	105	0.005 - 0.5	0	0%	--	--	120	No	
Diethyl phthalate	65	0.33 - 4.95	0	0%	--	--	29000	No	
2,4-Dimethylphenol	63	10	0	0%	--	--	730	No	
Dimethyl phthalate	65	0.33 - 4.95	0	0%	--	--	370000	No	
4,6-Dinitro-2-methylphenol	61	25	0	0%	--	--	3.7	No	
Di-n-butyl phthalate	61	10	3	5%	0.79 - 2.9	2.9	NA	No	
Di-n-octyl phthalate	61	10	0	0%	--	--	1500	No	
2,4-Dinitrophenol	61	25	0	0%	--	--	73	No	
Hexachlorocyclopentadiene	65	0.33 - 4.95	0	0%	--	--	220	No	
Isophorone	63	10	0	0%	--	--	70	No	
2-Methylphenol	63	10	1	2%	20	20	1800	No	
4-Methylphenol	15	10	0	0%	0.93	0.93	180	No	
Methoxychlor	42	0.2	0	0%	--	--	180	No	
N-Nitrosodiphenylamine	65	0.33 - 4.95	0	0%	--	--	14	No	
N-Nitroso-di-n-propylamine	65	0.33 - 4.95	0	0%	--	--	NA	No	
2-Nitroaniline	61	10	0	0%	--	--	110	No	
3-Nitroaniline	61	25	0	0%	--	--	3.3	No	
Phenol	63	10	0	0%	--	--	11000	No	
2,4,6-Trichlorophenol	61	10	0	0%	--	--	6.1	No	

Table 3. Identification of Groundwater Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (ug/L)	Number Of Detects	Frequency of Detection (%)	Range (ug/L)	Maximum Reported (ug/L)	Residential Region III Tap Water (ug/L)	COPC	UCL
PAHs									
Acenaphthene	61	10	3	5%	1.0 - 5.0	5	370	No	
Acenaphthylene	61	10	0	0%	10	10	370	No	
Anthracene	61	10	0	0%	0.87 - 2.2	2.2	1800	No	
Benzo(a)anthracene	61	10.0 - 50	0	0%	0.99 - 31	31	0.092	No	
Benzo (a) Pyrene	61	10.0 - 50	0	0%	1.0 - 25	25	0.009	No	
Benzo (b) Fluoranthene	61	10.0 - 50	0	0%	0.87 - 22	22	0.09	No	
Benzo (k) Fluoranthene	61	10.0 - 50	0	0%	0.87 - 20	20	0.92	No	
Benzo (g,h,i) Perylene[a]	61	10.0 - 50	0	0%	0.55 - 13	13	180	No	
Chrysene	61	10.0 - 50	0	0%	0.5 - 20	20	9.2	No	
Dibenzo (a,h) anthracene	61	10.0 - 50	0	0%	0.87 - 4.1	4.1	0.009	No	
Fluoranthene	61	10	0	0%	0.53 - 64	64	1500	No	
Fluorene	61	10	0	0%			240	Yes	
Naphthalene	183	10.0 - 50	29	16%	3 - 110	110	7	**Yes**	111
Phenanthrene[b]	61	10	3	5%	1.0 - 8	8	1800	No	
Pyrene	61	10	0	0%	0.06 - 100	100	180.00	No	
Indeno(1,2,3-c,d)pyrene	61	10	0	0%	0.52 - 13	13	0.092	No	
2-Methylnaphthalene	61	10	0	0%	0.045 - 68	68	24	No	
Pentachlorophenol	65	0.83 - 12.45	0	0%	--	--	0.56	No	
Pesticides/PCBs									
Aldrin	42	0.2 - 2	0	0%	--	--	0.0039	No	
Atrazine	61	10	0	0%	--	--	0.3	No	
alpha-BHC	42	0.2	0	0%	--	--	0.011	No	
beta-BHC	42	0.2	0	0%	--	--	0.037	No	
delta-BHC	42	0.2	0	0%	--	--		No	
gamma-BHC (Lindane)	42	0.2	0	0%	--	--	0.052	No	
alpha-Chlordane	42	0.2	0	0%	--	--	0.19	No	
gamma-Chlordane	42	0.2	0	0%	--	--	0.19	No	
Endosulfan I	42	0.2	0	0%	--	--	229.00	No	
Endosulfan II	42	0.2	0	0%	--	--	229.00	No	
Endrin	42	0.2	0	0%	--	--	11.00	No	
Endrin aldehyde	42	0.2	0	0%	--	--		No	
Heptachlor	42	0.2	0	0%	--	--	0.015	No	
Heptachlor epoxide	42	0.2	0	0%	--	--		No	
PCBs	57	0.0005	4	7%	0.001 - 0.003	0.003	0.03	No	
Dieldrin	42	0.2	0	0%	--	--	0.0042	No	
Toxaphene	42	5	0	0%	--	--	0.061	No	

NA- not available

Table 4. Identification of Sediment and Surface Water Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Soil Region III RBC (mg/kg)	COPC
SEDIMENT COPCs								
Inorganics								
Antimony	6	2.7	0	0%	--	--	410	No
Arsenic	6	0.5	2	33%	1.9 - 6	6	1.90	Yes
Beryllium	6	2.5	0	0%	--	--	2000.00	No
Chromium (Total)	6	2.7	6	100%	7.4 - 12000	12000	1500000	No
Copper	6	2.9	6	100%	9.5 - 13	13	3100	No
Cadmium	6	2.7	3	50%	5.2 - 600	600	1000	No
Copper	6	5	6	100%	9.5 - 200	200	41000	No
Lead	6	2.7	4	67%	3.5 - 210	210	NA	No
Mercury	6	0.04	2	33%	0.2 - 0.33	0.33	NA	No
Nickel	6	2.7	3	50%	25 - 92	92	20000	No
Selenium	6	1.35	0	0%	--	--	5100	No
Silver	6	1.35	1	17%	1.3	1.3	5100	No
Thallium	6	2.1	0	0%	--	--	72	No
Zinc	6	10	4	67%	63 - 790	790	310000	No
VOCs								
Acetone	6	0.063	1	17%	0.5	0.5	920000	No
Benzene	6	0.015	1	17%	0.044	0.044	52	No
n-butylbenzene	6	0.24	1	17%	1.6	1.6	NA	No
sec-butylbenzene	6	0.015	2	33%	0.13 - 0.94	0.94	NA	No
n-propylbenzene	6	0.015	2	33%	.32 - 1.7	1.7	NA	No
Carbon Disulfide	6	0.015	2	33%	.023 - .065	0.065	100000	No
Chlorobenzene	6	0.015	3	50%	.016 - 1.3	1.3	20000	No
c-1,2-Dichloroethene	6	0.006	2	33%	0.27 - 34	34	10000	No
Ethylbenzene	6	0.015	2	33%	.02 - 15	15	100000	No
Isopropylbenzene	6	0.015	2	33%	0.22 - 0.87	0.87	100000	No
p-isopropyltoluene	6	0.24	1	17%	1.6	1.6	NA	No
Methylene Chloride	6	0.006	2	33%	0.038 - 0.04	0.04	380	No
Toluene	6	0.029	3	50%	.029 - 35	35	200000	No
1,2,4-trimethylbenzene	6	0.015	2	33%	.091 - 14	14	51000	No
1,3,5-trimethylbenzene	6	0.015	2	33%	0.027 - 5.2	5.2	51000	No
Tetrachloroethene	6	0.24	1	17%	3.3	3.3	5.3	No
Trichloroethene	6	0.006	2	33%	0.32 - 69	69	7	No
Vinyl chloride	6	0.006	1	17%	0.009	0.009	4	No
Xylenes	6	0.03	2	33%	0.31 - 46	46	310000	No
SVOCs								
Benzo(a)pyrene	6	0.8	1	17%	1.7	1.7	0.39	Yes
Benzo(a)anthracene	6	0.8	1	17%	1.5	1.5	3.90	No
Benzo(b)fluoranthene	6	0.8	1	17%	1.6	1.6	3.90	No
Benzo(k)fluoranthene	6	0.8	1	17%	1.5	1.5	39.00	No
Benzo(g,h,i)perylene	6	0.8	1	17%	1.3	1.3	31000.00	No
Indeno(1,2,3-cd)pyrene	6	0.8	1	17%	1.4	1.4	3.90	No
Chrysene	6	0.8	1	17%	1.7	1.7	390.00	No
Fluoranthene	6	0.8	1	17%	2.9	2.9	41000.00	No
Phenanthrene	6	0.8	1	17%	1.8	1.8	310000.00	No
Pyrene	6	0.8	1	17%	2.9	2.9	31000.00	No
Naphthalene	6	0.015	3	50%	0.34 - 3.6	3.6	20000	No
BEHP	6	0.8	1	17%	5	5	200	No
PCBs/Pesticides								
PCBs/Pesticides	6	0.001	1	17%	0.003	0.003	1.4	No

Table 4. Identification of Sediment and Surface Water Chemicals of Potential Concern
Martin State Airport
Middle River, Maryland

Compound Name	Count	PQL (mg/kg)	Number Of Detects	Frequency of Detection (%)	Range (mg/kg)	Maximum Reported (mg/kg)	Industrial Soil Region III RBC (mg/kg)	COPC
							Tap Water RBCs	
SURFACE WATER COPCs		(ug/L)			(ug/L)		(ug/L)	
Inorganics								
Copper	8	5	4		13 - 17	17	1500	No
Zinc	8	50	1		95	95	11000	No
VOCs								
c-1,2-Dichloroethene	8	1	2		3.0 - 3.0	3	61	No
Trichloroethene	8	1	2		3.0 - 4.0	**4**	0.026	**Yes**
Methyl-t-butyl ether	8	1	2		7.0 - 7.0	7	2.6	**Yes**

NA - not available

TABLE 5
Estimated Risks due to Potential Soil Exposures
On-Site Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES	
EPCs = Concentration in soil	mg/kg	see table	
EF = Exposure Frequency	days/year	100	
ED = Exposure Duration	years	25	
BW = Body Weight, adult	kg	70	
ATnc = Averaging Time - noncarcinogen	days	9125	
ATc = Averaging Time - carcinogen	days	25550	
Kp = Permeability Coefficient	cm/hour	see table	
IngRad[a] = Ingestion Rate, adult	mg/day	50	
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/hour	1	
ET = Exposure Time	hrs/day	8	
SSA a = skin surface area, adult	cm2/day	5670	EFH, 8/97
CF = Conversion Factor	kg/mg	1.00E-06	
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table	
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table	
RfDing = Ingestion Reference Dose	mg/kg-day	see table	
RfDinh = Inhalation Reference Dose	mg/kg-day	see table	
AF = Adherence factor	mg/cm2	0.08	
ABS - absorption factor (inorg)	unitless	0.03	
PEF = Particulate Emission Factor	m^3/kg	7.80E+07	(EPA, 1996b)

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
Arsenic	21	0.03		1.57E-08	1.8E-10	1.5E-06	4.1E-07	1.5	15	2.6E-09	2.2E-06	6.1E-07	3.E-06
Benzo(a)pyrene	14.7	0.13		1.08E-08	1.2E-10	1.0E-06	1.2E-06	7.3	3.1	3.7E-10	7.5E-06	8.8E-06	2.E-05
Dibenz(a,h)anthracene	2.3	0.13		1.69E-09	1.9E-11	1.6E-07	1.9E-07	7.3	0	0.0E+00	1.2E-06	1.4E-06	3.E-06
Benzo(a)anthracene	17.6	0.13		1.29E-08	1.4E-10	1.2E-06	1.5E-06	0.73	0	0.0E+00	9.0E-07	1.1E-06	2.E-06
Benzo (b) Fluoranthene	13.0	0.13		9.56E-09	1.1E-10	9.1E-07	1.1E-06	0.73	0	0.0E+00	6.6E-07	7.8E-07	1.E-06
Indeno(1,2,3-c,d)pyrene	7.8	0.13		5.74E-09	6.4E-11	5.5E-07	6.4E-07	0.73	0	0.0E+00	4.0E-07	4.7E-07	9.E-07
Carbazole	4.6	0.10		3.38E-09	3.8E-11	3.2E-07	2.9E-07	2.00E-02	2.00E-02	7.6E-13	6.4E-09	5.8E-09	1.E-08
											TOTAL RISK		**3.E-05**

NON-CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		HQ			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	RfDing	RfDinh	Inhalation	Ingestion	Dermal	Total
Arsenic	21	0.03		1.57E-08	4.9E-10	4.2E-06	1.1E-06	3.0E-04	na	na	1.39E-02	3.78E-03	2.E-02
Mercury	0.35	0.01		2.57E-10	8.1E-12	6.8E-08	6.2E-09	2.0E-02	8.60E-05	na	3.42E-06	3.11E-07	4.E-06
											HAZARD INDEX =		**2.E-02**

na - not available

TABLE 6
Estimated Risks due to Potential Exposures to Sediments
On-Site Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES	
EPCsed = Concentration in sediment	mg/kg	see table	
EF = Exposure Frequency	days/year	100	
ED = Exposure Duration	years	25	
BW = Body Weight, adult	kg	70	
ATnc = Averaging Time - noncarcinogen	days	9125	
ATc = Averaging Time - carcinogen	days	25550	
Kp = Permeability Coefficient	cm/hour	see table	
IngRad[a] = Ingestion Rate, adult	mg/day	100	
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/hour	1	
ET = Exposure Time	hrs/day	8	
SSA a = skin surface area, adult	cm2/day	5670	
CF = Conversion Factor	kg/mg	1.00E-06	
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table	
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table	
RfDing = Ingestion Reference Dose	mg/kg-day	see table	
RfDinh = Inhalation Reference Dose	mg/kg-day	see table	
AF = Adherence factor	mg/cm2	0.08	
ABS - absorption factor (inorg)	unitless	0.03	
PEF = Particulate Emission Factor	m^3/kg	7.80E+07	(EPA, 1996b)

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
Benzo(a)pyrene	1.7	0.13		1.25E-09	1.4E-11	2.4E-07	1.4E-07	7.3	3.1	4.3E-11	1.7E-06	1.0E-06	3.E-06
											TOTAL RISK		3.E-06

TABLE 7
Estimated Risks due to Potential Soil Exposures
Construction Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES	
EPCs = Concentration in soil	mg/kg	see table	
EF = Exposure Frequency	days/year	250	
ED = Exposure Duration (EPA,1996a)	years	1	
BW = Body Weight, adult	kg	70	
ATnc = Averaging Time - noncarcinogen	days	365	
ATc = Averaging Time - carcinogen	days	25550	
Kp = Permeability Coefficient	cm/hour	see table	
IngRad[a] = Ingestion Rate, adult	mg/day	480	
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/hour	1.5	
ET = Exposure Time	hrs/day	8	
SSA a = skin surface area, adult	cm2/day	5670	
CF = Conversion Factor	kg/mg	1.00E-06	
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table	
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table	
RfDing = Ingestion Reference Dose	mg/kg-day	see table	
RfDinh = Inhalation Reference Dose	mg/kg-day	see table	
AF = Adherence factor	mg/cm2	0.08	
ABS - absorption factor (inorg)	unitless	0.03	
PEF = Particulate Emission Factor	m^3/kg	7.80E+07	(EPA, 1996b)

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
Arsenic	13	0.03		9.63E-09	1.6E-11	8.8E-07	2.5E-08	1.5	15	2.4E-10	1.3E-06	3.7E-08	1.E-06
Cadmium	170	0.01		1.25E-07	2.1E-10	1.1E-05	1.1E-07		6.3	1.3E-09	0.0E+00	0.0E+00	1.E-09
Benzo(a)pyrene	2.8	0.13		2.06E-09	3.5E-12	1.9E-07	2.3E-08	7.3	3.1	1.1E-11	1.4E-06	1.7E-07	2.E-06
Dibenz(a,h)anthracene	0.4	0.13		3.20E-10	5.4E-13	2.9E-08	3.6E-09	7.3	0	0.0E+00	2.1E-07	2.6E-08	2.E-07
Benzo(a)anthracene	2.1	0.13		1.54E-09	2.6E-12	1.4E-07	1.7E-08	0.73	0	0.0E+00	1.0E-07	1.3E-08	1.E-07
Benzo (b) Fluoranthene	1.1	0.13		8.09E-10	1.4E-12	7.4E-08	9.1E-09	0.73	0	0.0E+00	5.4E-08	6.6E-09	6.E-08
Indeno(1,2,3-c,d)pyrene	7.8	0.13		5.74E-09	9.6E-12	5.2E-07	6.4E-08	0.73	0	0.0E+00	3.8E-07	4.7E-08	4.E-07
Carbazole	2.1	0.10		1.54E-09	2.6E-12	1.4E-07	1.3E-08	2.00E-02	2.00E-02	5.2E-14	2.8E-09	2.7E-10	3.E-09
Vinyl chloride	0.4	0.03	1000.00	4.23E-04	7.1E-07	2.8E-08	8.0E-10	7.20E-01	1.50E-02	1.1E-08	2.0E-08	5.8E-10	3.E-08
											TOTAL RISK		4.E-06

NON-CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		HQ			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	RfDing	RfDinh	Inhalation	Ingestion	Dermal	Total
Antimony	201	0.01		1.48E-07	1.7E-08	9.4E-04	8.9E-06	4.0E-04	na	na	2.36E+00	2.23E-02	2.E+00
Copper	11849	0.01		8.71E-06	1.0E-06	5.6E-02	5.3E-04	4.0E-02	na	na	1.39E+00	1.31E-02	1.E+00
Arsenic	13	0.03		9.63E-09	1.1E-09	6.2E-05	1.7E-06	3.0E-04	na	na	2.05E-01	5.81E-03	2.E-01
Cadmium	170	0.01		1.25E-07	1.5E-08	8.0E-04	7.5E-06	1.0E-03	5.70E-05	na	7.98E-01	7.55E-03	8.E-01
Nickel	2308	0.01		1.70E-06	2.0E-07	1.1E-02	1.0E-04	2.0E-02	na	na	5.42E-01	5.12E-03	5.E-01
Mercury	0.39	0.01		2.87E-10	3.4E-11	1.8E-06	1.7E-08	2.0E-02	na	na	9.16E-05	8.65E-07	9.E-05
Vinyl chloride	0.4	0.03	1000.00	4.2E-04	5.0E-05	2.0E-06	5.6E-08	3.00E-03	2.80E-02	na	6.62E-04	1.88E-05	7.E-04
											HAZARD INDEX =		5.E+00

na - not available

TABLE 8
Estimated Risks due to Potential Sediment Exposures
Construction Worker Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES	
EPCs = Concentration in soil	mg/kg	see table	
EF = Exposure Frequency	days/year	250	
ED = Exposure Duration (EPA,1996a)	years	1	
BW = Body Weight, adult	kg	70	
ATnc = Averaging Time - noncarcinogen	days	365	
ATc = Averaging Time - carcinogen	days	25550	
Kp = Permeability Coefficient	cm/hour	see table	
IngRad[a] = Ingestion Rate, adult	mg/day	480	
InhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/day	20	
ET = Exposure Time	hrs/day	8	
SSA a = skin surface area, adult	cm2/day	5670	
CF = Conversion Factor	kg/mg	1.00E-06	
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table	
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table	
RfDing = Ingestion Reference Dose	mg/kg-day	see table	
RfDinh = Inhalation Reference Dose	mg/kg-day	see table	
AF = Adherence factor	mg/cm2	0.2	
ABS - absorption factor (inorg)	unitless	0.03	
PEF = Particulate Emission Factor	m^3/kg	7.80E+07	(EPA, 1996b)

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
Benzo(a)pyrene	1.7	0.13		1.25E-09	2.8E-11	1.1E-07	3.5E-08	7.3	3.1	8.7E-11	8.3E-07	2.6E-07	1.E-06
											TOTAL RISK		1.E-06

na - not available

TABLE 9
Estimated Risks due to Potential Sediment Exposures
Recreational Scenario

Martin State Airport

PARAMETERS	UNITS	VALUES
EPCs = Concentration in soil	mg/kg	see table
EF = Exposure Frequency	days/year	70
ED = Exposure Duration (EPA,1996a)	years	25
BW = Body Weight, adult	kg	70
ATnc = Averaging Time - noncarcinogen	days	9125
ATc = Averaging Time - carcinogen	days	25550
Kp = Permeability Coefficient	cm/hour	see table
ingRad[a] = Ingestion Rate, adult	mg/day	100
inhRad = Adult Inhalation Rate(EPA, 1996a, p.5-20)	m^3/day	20
ET = Exposure Time	hrs/day	8
SSA a = skin surface area, adult	cm2/day	5670
CF = Conversion Factor	kg/mg	1.00E-06
SFing = Ingestion Cancer Slope Factor	kg-day/mg	see table
SFinh = Inhalation Cancer Slope Factor	kg-day/mg	see table
RfDing = Ingestion Reference Dose	mg/kg-day	see table
RfDinh = Inhalation Reference Dose	mg/kg-day	see table
AF = Adherence factor	mg/cm2	0.2
ABS - absorption factor (inorg)	unitless	see below
PEF = Particulate Emission Factor	m^3/kg	7.80E+07

CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		RISK			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	SFing	SFinh	Inhalation	Ingestion	Dermal	Total
Arsenic	6.0	0.03		4.41E-09	6.9E-10	5.9E-07	1.2E-07	1.5	15	1.0E-08	8.8E-07	1.7E-07	1.E-06
											TOTAL RISK		1.E-06

NON-CARCINOGENS	Cs	ABS	VF	EPCa	DOSE			Toxicity Factors		HQ			
Chemical	(mg/kg)	unitless	m^3/kg	(mg/m^3)	Inhalation	Ingestion	Dermal	RfDing	RfDinh	Inhalation	Ingestion	Dermal	Total
Arsenic	6.0	0.03		4.41E-09	1.9E-09	1.6E-06	3.3E-07	3.0E-04	na	na	5.48E-03	1.08E-03	7.E-03
											HAZARD INDEX =		7.E-03

na - not available

TABLE 10
Risk Estimates due to Potential Surface Water Exposures
Recreational Scenario
Martin State Airport
Middle River, Maryland

Parameter	Description	Units	Value
Dose	Dose of chemical	mg/kg-day	See below
HI	Target hazard index	unitless	See below
Risk	Risk	unitless	See below
Cw	Chemical concentration in groundwater	mg/L	See below
Ca	Chemical concentration in air	mg/m3	See below
IRw	Groundwater ingestion rate	L/day	0.05
InhR	Inhalation rate	m3/hour	1
ET	Exposure Time	hrs/day	8
EF	Exposure frequency	days/year	70
ED	Exposure duration	years	25
BW	Body weight	kg	70
AP	Averaging period	days	See below
SSA	Skin surface area	cm^2	5670
Kp	Permeability constant	cm/hr	See below
CF1	Conversion factor, ug to mg	mg/ug	1.00E-03
CF2	Conversion factor, cm^3 to L	L/cm^3	1.00E-03
RfDo	Oral reference dose	mg/kg-day	See below
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below

Carcinogens					AP =	25,550	days						Total
Compound	**Cw**	**VF**	**Ca**	**CSFo**	**CSFi**	**Kp**	**$Dose_{ing}$**	**$Dose_{der}$**	**$Dose_{inh}$**	**$Risk_{ing}$**	**$Risk_{der}$**	**$Risk_{inh}$**	**Risk**
Trichloroethene	0.004	3.3E+03	1.2E-06	4.0E-01	4.0E-01	1.2E-02	2.0E-07	2.7E-10	0.0E+00	7.8E-08	1.1E-10	0.0E+00	7.8E-08
MTBE	0.007	4.7E+03	1.5E-06	4.0E-03		2.6E-03	3.4E-07	1.0E-10	0.0E+00	1.4E-09	4.0E-13	0.0E+00	1.4E-09
												Total Cumulative Risk	8.0E-08

TABLE 10
Risk Estimates due to Potential Surface Water Exposures
Recreational Scenario
Martin State Airport
Middle River, Maryland

Parameter	Description	Units	Value
Dose	Dose of chemical	mg/kg-day	See below
HI	Target hazard index	unitless	See below
Risk	Risk	unitless	See below
Cw	Chemical concentration in groundwater	mg/L	See below
Ca	Chemical concentration in air	mg/m3	See below
IRw	Groundwater ingestion rate	L/day	0.05
InhR	Inhalation rate	m3/hour	1
ET	Exposure Time	hrs/day	8
EF	Exposure frequency	days/year	70
ED	Exposure duration	years	25
BW	Body weight	kg	70
AP	Averaging period	days	See below
SSA	Skin surface area	cm^2	5670
Kp	Permeability constant	cm/hr	See below
CF1	Conversion factor, ug to mg	mg/ug	1.00E-03
CF2	Conversion factor, cm^3 to L	L/cm^3	1.00E-03
RfDo	Oral reference dose	mg/kg-day	See below
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below

Noncarcinogens	9,125 days													**Total**
Compound	**Cw**	**VF**	**Ca**	**RfDo**	**RfDi**	**Kp**	**$Dose_{ing}$**	**$Dose_{der}$**	**$Dose_{inh}$**	**HI_{ing}**	**HI_{der}**	**HI_{inh}**		**HI**
MTBE	0.007	4.7E+03	1.5E-06		8.6E-01	2.6E-03	9.6E-07	2.8E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00		0.0E+00
Trichloroethene	0.004	3.3E+03	1.2E-06	3.0E-04	1.0E-02	1.2E-02	5.5E-07	7.5E-10	0.0E+00	1.8E-03	2.5E-06	0.0E+00		1.8E-03
												Total Hazard Index		1.8E-03

Table 11
Summary of Estimated Risks and Hazard Indices
Martin State Airport
Middle River, Maryland

Exposure Scenario	Estimated Carcinogenic Risks	Estimated Hazard Index
On-Site Worker		
Soil	3.E-05	0.02
Sediment	3.E-06	--
Future Construction Worker		
Soil	4.E-06	5
Sediments	1.E-06	--
Recreational User		
Sediment	1.E-06	0.007
Surface Water	8.E-08	0.002

LEAD RISK ASSESSMENT SPREADSHEET

Table 12. Evaluation of Lead in Surface Soil

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	160.0
Lead in Water (ug/l)	15
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.3	2.3	2.7	3.3	3.8	2417	3809
BLOOD Pb, CHILD	2.7	4.9	5.8	7.0	8.0	255	435
BLOOD Pb, PICA CHILD	3.8	6.9	8.2	10.0	11.4	128	219
BLOOD Pb, OCCUPATIONA	1.2	2.2	**2.6**	3.2	3.6	3465	5448

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	3300	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/da	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/da	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/da	0.08	0.19
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	72.0	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.01	0%	1.6E-5	0.00	0%
Soil Ingestion	8.8E-4	0.14	11%	6.3E-4	0.10	8%
Inhalation, bkgrnd		0.05	4%		0.03	3%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	66%		0.84	69%
Food Ingestion, bkgrnd		0.23	18%		0.23	19%
Food Ingestion	0.0E+0	0.00	0%			0%
CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.01	0%		0.01	0%
Soil Ingestion	7.0E-3	1.13	42%	1.4E-2	2.25	59%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	1%		0.04	1%
Water Ingestion		0.96	36%		0.96	25%
Food Ingestion, bkgrnd		0.54	20%		0.54	14%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

LEAD RISK ASSESSMENT SPREADSHEET

Table 13. Evaluation of Lead in Subsurface Soil

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	4361.0
Lead in Water (ug/l)	15
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	5.1	9.4	11.1	13.5	15.4	2417	3809
BLOOD Pb, CHILD	32.5	59.4	70.2	85.4	97.1	255	435
BLOOD Pb, PICA CHILD	63.2	115.4	136.6	166.0	188.9	128	219
BLOOD Pb, OCCUPATIONA	3.9	7.2	8.5	10.3	11.7	3465	5448

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	3300	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/d	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/d	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/d	0.08	0.19
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	1962.5	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.17	3%	1.6E-5	0.07	2%
Soil Ingestion	8.8E-4	3.84	75%	6.3E-4	2.74	70%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.01	0%	1.8E-6	0.01	0%
Water Ingestion		0.84	16%		0.84	21%
Food Ingestion, bkgrnd		0.23	5%		0.23	6%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.24	1%		0.24	0%
Soil Ingestion	7.0E-3	30.70	94%	1.4E-2	61.40	97%
Inhalation	2.0E-6	0.01	0%		0.01	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	3%		0.96	2%
Food Ingestion, bkgrnd		0.54	2%		0.54	1%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

TABLE14
Calculation of Surface Water Risk-Based Levels
Martin State Airport
Middle River, Maryland

Parameter	Description	Units	Value	Reference
Dose	Dose of chemical	mg/kg-day	See below	Calculated
HI	Target hazard index	unitless	See below	Calculated
Risk	Risk	unitless	See below	Calculated
Csw	Chemical concentration in surface water	mg/L	See below	Calculated
Ca	Chemical concentration in air	mg/m3	See below	Modeled
IRw	Groundwater ingestion rate	L/day	0.05	USEPA, 1996a
InhR	Inhalation rate	m3/day	20	USEPA, 1996a
EF	Exposure frequency	days/year	70	USEPA, 1996a
ED	Exposure duration	years	25	USEPA, 1996a
ET	Exposure time	hours/day	8	USEPA, 1996a
BW	Body weight	kg	70	USEPA, 1996a
AP	Averaging period	days	See below	USEPA, 1989
SSA	Skin surface area	cm^2	5670	USEPA, 1996a
Kp	Permeability constant	cm/hr	See below	USEPA, 1992
CF1	Conversion factor, ug to mg	mg/ug	1.00E-03	Constant
CF2	Conversion factor, cm^3 to L	L/cm^3	1.00E-03	Constant
RfDo	Oral reference dose	mg/kg-day	See below	USEPA, 1998, 1996
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below	USEPA, 1998, 1996

Carcinogens					AP =	25,550	days						**Total**
Compound	**Cw**	**VF**	**Ca**	**CSFo**	**CSFi**	**Kp**	**$Dose_{ing}$**	**$Dose_{der}$**	**$Dose_{inh}$**	**$Risk_{ing}$**	**$Risk_{der}$**	**$Risk_{inh}$**	**Risk**
Trichloroethene	0.01	3.3E+03	3.0E-04	4.0E-01	4.0E-01	1.2E-02	2.4E-07	2.7E-06	0.0E+00	9.8E-08	1.1E-06	0.0E+00	1.2E-06
Vinyl chloride	0.004	3.3E+03	3.0E-04	7.5E-01	1.6E-02	6.4E-03	2.0E-07	1.1E-06	0.0E+00	1.5E-07	8.5E-07	0.0E+00	1.0E-06
Cadmium	--			0.0E+00	6.3E+00	1.0E-03	--	--	0.0E+00	--	--	0.0E+00	0.0E+00
												Total Cumulative Risk	5.2E-06

TABLE14
Calculation of Surface Water Risk-Based Levels
Martin State Airport
Middle River, Maryland

Parameter	Description	Units	Value	Reference
Dose	Dose of chemical	mg/kg-day	See below	Calculated
HI	Target hazard index	unitless	See below	Calculated
Risk	Risk	unitless	See below	Calculated
Csw	Chemical concentration in surface water	mg/L	See below	Calculated
Ca	Chemical concentration in air	mg/m3	See below	Modeled
IRw	Groundwater ingestion rate	L/day	0.05	USEPA, 1996a
InhR	Inhalation rate	m3/day	20	USEPA, 1996a
EF	Exposure frequency	days/year	70	USEPA, 1996a
ED	Exposure duration	years	25	USEPA, 1996a
ET	Exposure time	hours/day	8	USEPA, 1996a
BW	Body weight	kg	70	USEPA, 1996a
AP	Averaging period	days	See below	USEPA, 1989
SSA	Skin surface area	cm^2	5670	USEPA, 1996a
Kp	Permeability constant	cm/hr	See below	USEPA, 1992
CF1	Conversion factor, ug to mg	mg/ug	1.00E-03	Constant
CF2	Conversion factor, cm^3 to L	L/cm^3	1.00E-03	Constant
RfDo	Oral reference dose	mg/kg-day	See below	USEPA, 1998, 1996
CSFo	Oral cancer slope factor	$(mg/kg\text{-}day)^{-1}$	See below	USEPA, 1998, 1996

Noncarcinogens	9,125 days												**Total**
Compound	**Cw**	**VF**	**Ca**	**RfDo**	**RfDi**	**Kp**	**$Dose_{ing}$**	**$Dose_{der}$**	**$Dose_{inh}$**	**HI_{ing}**	**HI_{der}**	**HI_{inh}**	**HI**
Trichloroethene	0.01	3.3E+03	3.0E-04	3.0E-04	1.0E-02	1.2E-02	6.8E-07	7.5E-06	1.7E-05	2.3E-03	2.5E-02	1.7E-03	2.9E-02
Vinyl chloride	0.004	3.3E+03	3.0E-04	3.0E-03	2.9E-02	6.4E-03	5.5E-07	3.2E-06	1.7E-05	1.8E-04	1.1E-03	5.8E-04	1.8E-03
cis-1,2-dce	1.10	**1.0E+02**	1.0E-02	1.0E-02	na	6.4E-03	1.5E-04	8.7E-04	5.5E-04	1.5E-02	8.7E-02	---	1.0E-01
Cadmium	0.20			5.0E-04	5.7E-05	1.0E-03	2.7E-05	2.5E-05	0.0E+00	5.5E-02	5.0E-02	0.0E+00	1.0E-01
												Total Hazard Index	2.2E-01